

## **Historic, Archive Document**

Do not assume content reflects current scientific knowledge, policies, or practices.

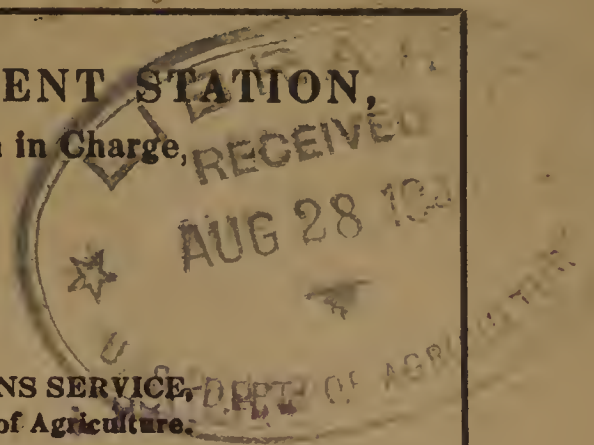


1  
Exp. 67  
Exp. 4

**GUAM AGRICULTURAL EXPERIMENT STATION,**  
**C. W. EDWARDS, Animal Husbandman in Charge,**  
Island of Guam.

**BULLETIN No. 2.**

Under the supervision of the STATES RELATIONS SERVICE,  
Office of Experiment Stations, U. S. Department of Agriculture.



**VEGETABLE GROWING IN  
GUAM.**

BY

**GLEN BRIGGS, Agronomist and Horticulturist**



Issued June, 1922



**WASHINGTON:**  
**GOVERNMENT PRINTING OFFICE.**  
1922.





**GUAM AGRICULTURAL EXPERIMENT STATION,**  
**C. W. EDWARDS, Animal Husbandman in Charge,**  
Island of Guam.

**BULLETIN No. 2.**

---

Under the supervision of the STATES RELATIONS SERVICE,  
Office of Experiment Stations, U. S. Department of Agriculture.

**VEGETABLE GROWING IN  
GUAM.**

BY

**GLEN BRIGGS, Agronomist and Horticulturist**

Issued June, 1922



WASHINGTON:  
GOVERNMENT PRINTING OFFICE.  
1922.

## GUAM AGRICULTURAL EXPERIMENT STATION, ISLAND OF GUAM.

[Under the supervision of A. C. TRUE, Director, States Relations Service, United States Department of Agriculture.]

E. W. ALLEN, *Chief, Office of Experiment Stations.*  
WALTER H. EVANS, *Chief, Division of Insular Stations,*  
*Office of Experiment Stations.*

### STATION STAFF.

C. W. EDWARDS, *Animal Husbandman in Charge.*  
GLEN BRIGGS, *Agronomist and Horticulturist.*<sup>1</sup>  
W. J. GREEN, *Superintendent of Extension Work.*<sup>2</sup>  
JOAQUIN GUERRERO, *Assistant in Horticulture.*  
PETER NELSON, *Assistant.*

---

<sup>1</sup> Resigned, June 6, 1921.

<sup>2</sup> Resigned, November 10, 1921.

# VEGETABLE GROWING IN GUAM.

---

## CONTENTS.

	Page.		Page.
Introduction .....	1	Seed bed preparation.....	10
Importance of a garden.....	2	Planting .....	10
Success with the garden.....	2	Cultivation.....	15
Climate .....	3	Fences and windbreaks.....	17
Soils.....	3	Plant enemies.....	17
Seed.....	4	Detailed cultural directions.....	24
Manures and fertilizers.....	8		

---

## INTRODUCTION.

In Guam, as elsewhere in the Tropics, there is very little definite information available concerning proper methods either of planting or of growing vegetables. Work with vegetables, partly in an experimental way and partly to demonstrate methods of production, has been in progress at the Guam Agricultural Experiment Station since its establishment in 1909. Before this time very few garden vegetables were grown by the natives of Guam. Since the American occupation there has been a general increase in the growing of many of the vegetables which are raised in the States (Pl. I, fig. 1). Nearly all of the common vegetables can be grown in Guam, but those which are introduced from America must be planted in certain seasons for their best development.

Methods adopted for the production of the common vegetable in the States or in the Temperate Zone generally require some modification in the Tropics. These differences are often seemingly insignificant, but upon them depends success or failure in vegetable gardening. Seed which grows well in the temperate regions often fails to germinate in Guam, or the plants fail to produce edible crops. Failure is often caused by loss of vitality of seed, neglect to plant at the proper time, or to select the proper soil, or probably by the adoption of methods of cultivation which are not suitable for Guam. To overcome these difficulties and to determine the best time to plant for yield as well as for quality, the station has conducted 10 years' work with variety tests, Guam-grown seed in comparison with imported seed, and with fertilizers to learn their effect on plant growth and the proper time for application. The data secured from these experiments are deemed comparatively reliable for the average season in Guam.



Many of the Guam farmers and gardeners have not yet learned how to plant and care for their vegetables properly or how to use American vegetables, and in many cases it has been observed that they become discouraged and abandon all further efforts after they have made a few unsuccessful attempts to grow vegetables. For these reasons this bulletin deals with the subject somewhat in detail.

### IMPORTANCE OF A GARDEN.

Probably the principal reason for growing vegetables is to add materially to the family food supply throughout the year. However, if the garden is handled in such a manner as to produce a surplus of products, it should also add to the family income. When produced for home use, vegetables can be substituted to some extent for such expensive foods as meats, rice, and corn, and at the same time they will furnish the family with a wholesome diet. Many vegetables are healthful in that they supply the body with certain mineral and other substances. Likewise, they help to build up the body and keep it in good working condition. Every family should therefore eat plenty of them.

Growing vegetables on a commercial scale has been practiced in a very limited way in Guam. The demands of the American colony and of the Chamorro people, who are engaged in pursuits other than agriculture, seem to offer a splendid opportunity for a number of the small gardeners and producers to work in cooperation in a more extensive manner than they now do for the production of fruits and vegetables. A well-managed market should supply the island with sufficient quantities and a great variety of vegetables as well as with certain fruits.

### SUCCESS WITH THE GARDEN.

Success with the garden requires some thought and planning before planting. The soil should receive proper and thorough preparation, and the seed should be planted at the right time and at a given distance and depth. Timely cultivation is necessary, and the plants must be kept supplied with sufficient plant food if they are to grow. Windbreaks and fences should be provided, because they afford shade and protection for the vegetables. Insect pests and diseases must be guarded against or brought under control if large crops are to be expected.

The garden should be made in an easily accessible place if other conditions are suitable, because it will then be within convenient reach during spare time and also more likely be properly cared for than a garden which is situated on top of a steep hill, or at considerable distance from the house or ranch. The home garden can be easily and

readily protected against stray animals which destroy crops; and fresh vegetables can be harvested as they are needed.

When the vegetables are grown on a commercial basis, they should be marketed in such a way as to bring the top prices.

### CLIMATE.

Climatic conditions have much to do with the success or failure of growing vegetables. In Guam the seasons are the dry and the rainy, which, however, are not so pronounced as in many parts of the Tropics. They do not begin and end abruptly, but gradually merge into one another. Sometimes they are very definite and of long duration. The dry season generally extends from November to June and the rainy from July to November. It is seldom that the average yearly rainfall is greater than 100 inches, and the average for 14 years has been found to be 90.86 inches.

The temperature is tropical and is fairly uniform for the year, rarely varying more than  $25^{\circ}$  F. during the whole year. The mean average temperature is about  $81^{\circ}$  F. The highest temperature for the year is seldom above  $95^{\circ}$  F. and the lowest record rarely goes below  $70^{\circ}$  F. In the latter part of the rainy season, or soon afterwards, the weather becomes much cooler than in the dry season. This feature, together with the variation in precipitation during the year, has led the station to experiment with planting at different seasons. As a result, the most favorable seasons for the different vegetables have been fairly well determined.

One of the drawbacks to the agricultural progress of the island has been the destructive hurricanes, or typhoons as they are called in the Orient, which occasionally occur in this part of the Pacific Ocean. They have caused actual suffering in Guam by destroying the main crops, such as corn, coconuts, bananas, and various tropical fruits requiring long periods for development. This drawback seems partly overcome now that the station has introduced many vegetables requiring short seasons for their production, and has found a better means of growing them than was formerly the case.

### SOILS.

A soil of a light or loamy type produces the best vegetables because it is easily worked. A soil which will grow other agricultural crops will produce vegetables with at least a fair degree of success provided that it is properly handled. A heavy clay is difficult to work and a soil that is too sandy quickly dries out and contains very little plant food. The heavy, stiff clays retain moisture very readily, but during the dry season they become hard and compact and are likely to crack.



These can be greatly benefited if they are given proper drainage and green crops are turned under to furnish a large amount of organic matter for plant food. Cowpeas, mungo beans, or velvet beans are among the best crops for this purpose. Any soil on which water stands for long periods is undesirable for growing vegetables.

A sandy loam soil has a decided advantage over other soils for garden purposes, because it is easily worked and does not run together after heavy rains, nor does it bake and crack during the dry season. Fertilizers become more effective and plants respond to the treatment much quicker on a sandy loam than they do on a clay or sandy soil. This type of soil also offers another important advantage in that it can be worked soon after a rain, especially during the rainy season, and it does not puddle from the trampling during cultivation and harvesting.

In choosing a location for the garden it is best to select a well-drained area having as fertile soil as possible. Too sandy soil contains only little plant food, and rocky soil is hard to plant and cultivate.

#### SEED.

Seed from the outside world is very hard to obtain in Guam on account of excessive freight rates, general transportation difficulties, and the distance of the island from any seed house. Guam has no seed merchants, and the station has tried to fill this need by distributing to interested farmers seed which it receives in regular monthly shipments. Home-grown seed is as a rule poorly selected and generally produces inferior plants. However, when such seed is wisely selected and given proper care and storage it germinates and produces well. It is essential that all the seed be thoroughly dried and properly stored, else it will soon deteriorate in the relatively humid air of Guam. Seed will not keep in good condition when it is stored in the open. Some seed, such as that of the onion, germinates poorly after coming from the States, and seeds of many other vegetables lose their viability in less than three months after arrival unless they are properly stored. If the seed is dry and is kept in an air-tight container, it will keep for some time.

Good seed is the first requisite for success in the growing of vegetables. Only seed which comes direct from the States or other reliable markets, or carefully preserved seed which has been properly selected from the best plants available on the island, should be used. Only good viable seed should be planted. Seed that has been selected from poor plants or after all the best vegetables have been harvested should not be planted because it will produce a poor quality of vegetables. Old seed in most cases will not germinate in this tropical climate.

One of the best means of making certain that seed will germinate and produce good or superior fruit is to take it from selected plants only. Like tends to produce like, especially in plant life. Therefore in selecting seed one should take it from the kind of plant that he wishes to reproduce. For instance, if tomatoes are to be grown, seed should be selected from a healthy plant producing a large number of good sized, well-shaped fruits. Other things being considered, the early-maturing fruits should be selected for seed purposes. Seed should not be selected from a plant which produces more and larger fruit on account of its being given more space or better fertilizer. Likewise, seed should not be selected from the best fruits on a plant bearing some fine specimens and a large number of small or inferior ones, because such seed will likely produce the same kind of a plant. Select and carefully save the seed obtained from the healthy plant which not only grows among others, but also bears larger, better, and more fruit at the same time. By giving careful attention every season to these small matters the gardener will soon be rewarded with an improved variety that is adapted to local environment.

It is a common belief in Guam that vegetables which are obtained from the first generation of Guam-grown seed are inferior to those obtained from the imported seed. This belief arises from the fact that fresh imported seed is largely secured at the beginning of the two regular planting seasons, which are the most favorable times for vegetable growth. At other times the farmer is less interested and plants home-grown seed. Naturally, it does not return as great a yield as the imported seed because the plants must contend with heavy rains or drought, excessive heat, poor soil conditions, and other unfavorable conditions. As a result of these conditions there is unsatisfactory plant growth and low yields which are naturally, but unfairly, attributed to the rapid degeneration of the seed due to the effect of the tropical climate. The faulty methods of collecting, drying, and storing also cause much of the seed that is harvested in one favorable season to be useless for planting in the next favorable season; moreover, often there is left to supply the demand, when production is very low, only seed that has been produced under unfavorable conditions.

#### SEED CONTAINERS.

Of almost equal importance to those of seed selection are methods of preserving seeds from the time of harvesting until the next planting season. The station early developed a means of preserving seed for a reasonable length of time, both in large and small containers, and for the past 12 years these methods have been found very satisfactory. (Pl. I, fig. 2.) As an outcome of the station's suggestions



the more progressive farmers are adopting these methods. Until recently these containers were in the majority of cases used for preserving corn. However, they have been found equally as effective for preserving vegetable or other seed.

The larger container consists of a metal tank, which is made of galvanized sheet iron, having at the top an opening large enough to permit the easy filling and emptying of the tank. The opening is surrounded by two concentric circular collars which are soldered to the top. The outer collar is about 2 inches wider in diameter than the inner one, from which it is separated by an inch of space. The inner collar is nearly 2 inches high and is at least a quarter of an inch higher than the outer collar. A tight-fitting lid, which has a deep flange extending well down over the inner collar, covers the opening. Coconut or other slowly volatile oil is poured in the space between the two collars until it covers the edge of the flange on the lid. This hermetically seals the tank. The higher inside collar prevents the oil from flowing into the tank and the flange of the lid extending into the oil makes the tank air-tight and proof against moisture-laden air or against insects. Seeds will keep in good condition and maintain their germinating power for an indefinite period provided that they are free from insects and insect eggs and properly dried when they are placed in the tank. This type of container is also of advantage in that weevil-infested seeds can be easily fumigated in it. Care must be taken to see that the tank is allowed to stand open for a short time after fumigating, to prevent the seeds from being killed by overfumigation.

Bottles, glass jars, and tin boxes have also been found to make satisfactory containers. The seed should be thoroughly dry when it is placed in these containers. Bottles should be well corked, the stopper extending at least half an inch into the neck, and coconut oil should be poured on top, being replenished as it evaporates. Vaseline, thin axle grease, machine oil, and the like can also be used. These not only effectively seal the bottle but make it moisture, insect, and rat proof.

Burned lime that is fresh and dry should be placed in jars and tin cans for storing seed. This can be left loose with the seeds as it will not affect their germinating power, or it can be placed in small cloth bags for the sake of convenience. The dry lime readily absorbs any excess moisture in the container.

By carefully selecting seed from vigorous fruitful plants of the best varieties, attending to curing and drying of the seed and to proper storage, one can be sure of good vegetable seed from the garden for use for planting when needed.



LONGEVITY OF VEGETABLE SEED.

It has been noted that seeds rapidly lose their viability in Guam. In order to secure specific data on the longevity of vegetable seeds an experiment was conducted at the experiment station with various seeds under two different conditions of storage. Seeds were obtained from a San Francisco firm. Before the experiments were started the seeds were tested to make certain that they were fresh and viable. In one experiment the seeds were stored in exhibition jars having ground glass tops, and in the other they were put in cloth sacks and placed in insect-proof wooden cabinet drawers. Duplicate sets of seed were used in each germination test, 100 seeds (40 of the beans) being placed between sheets of blotting paper, which were kept moist between two plates, one inverted over the other. Two tests requiring nearly two years for completion were carried on, the first starting on August 1, 1915, and ending on March 15, 1917, and the second beginning September 1, 1916, and ending the following June. The following table gives the results obtained up to and including the June 15 test:

Comparative percentages of germination of vegetable seeds stored in jars and sacks.

Date of test.	Carrot.		Pepper.		Water-melon.		Cucum-ber.		Okra.		Radish.		Wax bean.		Lima bean.	
	Jars.	Sacks.	Jars.	Sacks.	Jars.	Sacks.	Jars.	Sacks.	Jars.	Sacks.	Jars.	Sacks.	Jars.	Sacks.	Jars.	Sacks.
Aug. 1.....	57	60	70	63	74	71	95	94	83	95	100	100	100	100	100	100
Sept. 1.....	57	41	52	57	77	81	96	93	91	92	94	94	98	98	98	98
Sept. 15.....	47	31	39	44	77	82	91	96	80	79	94	93	98	98	98	98
Oct. 1.....	46	34	34	21	85	81	94	94	88	80	95	95	98	90	98	95
Oct. 15.....	46	32	38	36	84	63	88	78	87	73	93	90	93	80	98	98
Nov. 1.....	51	19	15	8	64	70	92	91	92	90	95	93	98	98	98	95
Nov. 15.....	33	7	27	4	78	60	92	63	83	71	93	93	98	45	100	88
Dec. 1.....	32	10	27	12	57	62	86	54	84	71	89	73	95	....	98	75
Dec. 15.....	38	....	20	....	55	57	71	19	87	60	95	70	95	....	98	78
Jan. 1.....	31	....	16	....	38	32	81	17	84	46	86	47	68	....	98	55
Jan. 15.....	16	....	15	....	39	26	66	36	74	22	87	35	83	(1)	98	48
Feb. 1.....	27	(1)	18	(1)	41	30	66	8	79	45	82	25	80	....	93	28
Feb. 15.....	36	....	17	....	55	34	57	2	70	18	89	30	75	....	95	8
Mar. 1.....	19	....	12	....	32	26	54	4	74	22	88	17	88	....	95	....
Mar. 15.....	21	....	....	....	38	25	39	....	72	24	90	19	70	....	93	....
Apr. 1.....	11	....	3	....	38	26	54	5	74	2	86	17	60	....	93	....
Apr. 15.....	6	....	....	....	55	39	43	....	76	26	94	27	75	....	85	....
May 1.....	19	....	....	....	32	7	23	....	59	22	91	23	53	....	85	....
May 15.....	25	....	....	....	36	15	18	....	80	17	76	....	38	....	90	....
June 1.....	8	....	(1)	....	25	6	12	(1)	65	....	68	....	53	....	88	....
June 15.....	....	....	....	....	36	2	8	....	58	....	47	....	30	....	75	....

<sup>1</sup> Test discontinued.

The table following gives the number of days from the beginning of both first and second tests to the time when none of the seed was viable, as was shown by several additional germination tests.

*Number of days from date of starting germination test to date of complete absence of viability.*

Seed tested.	Test No. 1.		Test No. 2.		Average.	
	Jars.	Sacks.	Jars.	Sacks.	Jars.	Sacks.
Carrot.....	319	122	257	257	288.0	189.5
Pepper.....	228	137	75	137	151.5	137.0
Watermelon.....	380	334	300	300	340.0	317.0
Cucumber.....	334	227	257	257	295.5	242.0
Okra.....	549	304	300	300	424.5	302.0
Radish.....	564	319	257	257	410.5	278.0
Wax bean.....	365	122	227	196	296.0	159.0
Lima beans.....	518	212	257	257	387.5	234.5

It would appear from this experiment that for seed-storage purposes glass jars are preferable to sacks kept in wooden drawers. It also appears that neither method will keep the seed in good condition for an entire year if the containers are opened at frequent intervals, as in taking samples for germination in the above-mentioned trials.

#### MANURES AND FERTILIZERS.

Plants secure food from the soil through their roots. The soil should, therefore, be fertile and well supplied with humus. Fertility is expressed by the amount of available plant food in the soil. Plant food exists in soil in relatively small amounts and can not be used by the plant until it has been dissolved. Water dissolves substances in the soil and makes them available as plant food. Land that is cropped again and again without the addition of some organic matter soon becomes exhausted and the crops yield less each year. Manures and fertilizers must be incorporated with the soil if the fertility of the garden is to be kept up. There are four kinds of manure that can be used by Guam farmers: (1) Waste products; (2) manure of horses, cattle, pigs, chickens, bats, and the like; (3) green manure crops; and (4) commercial fertilizers.

After a field is cleared, the wood, brush, and weeds, as soon as dry, usually are burned. This is a good practice in Guam, where weeds and brush grow thickly, and it is the only means of clearing the land, because farm implements, which turn under this kind of material, are not in general use. The wood ashes make a ready source of potash, and, when used as a fertilizer, improve the mechanical condition of the soil. In case the brush has been piled high before burning, the ashes should be scattered evenly over the whole area. Other waste products that can be used include weeds, leaves, and all kinds of refuse from around the house, as for example, ashes, decayed fish, kitchen garbage, seaweed, and anything that will soon decay. These should be piled in a heap and allowed to decay, and



the pile should be turned over once in a while so that the material will be well mixed. At the end of six months it should be scattered broadcast over the fields. No diseased plant material should be included, because it would likely be the means of scattering the disease.

Manure from farm animals is probably the best material to use when the fertility of the soil needs to be restored or brought up to normal. This not only contains important fertilizing elements but also furnishes the soil with organic matter and makes it looser, more friable, and easier to work. Unfortunately, on account of there being few stabled animals in Guam, this kind of fertilizer is scarce. Bat manure, or guano, can be obtained in many of the caves in Guam and is fairly high in nitrogen and phosphorus, two principal fertilizers for garden soils. This material can be easily scattered over the soil and gives a large return for the time and labor required in getting and applying it. Gardeners are advised to use this kind of fertilizer because of its low cost and its stimulating effect on plant growth.

Next in importance to the use of animal manure is the practice of plowing under green crops. This method of farming is called green manuring. It is probably one of the most practical means of supplying manure for the Guam garden. Any vegetable matter worked into the soil improves the physical as well as the chemical condition of that soil. When plants are returned to the soil on which they were grown they do not enrich it, but give back only the same amount of fertility that they took from it, unless, of course, they derive some fertilizing element from another source. Plants of the bean or pea family known as legumes take free nitrogen from the air and store it in their roots by the help of bacteria found in the soil. For this reason these plants should be preferred for green-manure crops. The cow-pea, mungo bean, and velvet bean are suitable for this purpose. Soils to which green manure has been added show very noticeable differences. They are more easily worked, do not run together, bake, or crack, and produce better crops than soils not receiving a large amount of organic matter.

Mineral salts which contain plant food in a concentrated form are also used as fertilizers. These are known as commercial fertilizers because they are partly manufactured and partly imported from various places. They supply nitrogen, phosphorus, or potassium, and in some cases all three elements in a mixed form. These are the essential plant foods that are likely to be missing from the soil. Lime is sometimes added to sweeten sour or stale soils. These fertilizers are generally expensive and add nothing to the soil to improve its physical condition. They should be applied only to well-prepared soil having sufficient organic matter to make it till easily.

The experiment station has made many plat tests to determine the effect of manure and fertilizers on yields of vegetables, and to learn

the needs of Guam soils. Nearly all the soils have readily responded to applications of manure and fertilizers. The general effects have been increased production, better quality of vegetables, and in some cases, greater resistance to insects, or at least an increase in ability to overcome or recover from their ravages.

### SEED BED PREPARATION.

The seed bed should be very carefully prepared and the more thorough the care given it the better the growth of the plants will be. No plant can make good growth unless its roots are able to push out freely in all directions for food. Seed germinates and plants grow best in soil that is soft and mellow rather than soggy or puddled.

A garden can best be deeply prepared with a plow because this implement has many advantages over the native tools. When a plow can not be had, a fosiño, hoe, or mattock may be used to dig up the soil, which must be loosened to a sufficient depth. After it is plowed, the soil should be harrowed or carefully raked so that all clods and lumps will be broken into small pieces. This is absolutely essential and saves much labor later on.

It is very important that the garden have good drainage. Garden vegetables should not be planted where the ground is so low that water will stand upon it, because under such conditions the plants will make very little, if any, growth. During the rainy season seed beds on the lowlands should be slightly raised before planting. During the dry season, however, the soil produces better if the beds are not raised. When this is necessary, the beds should be raised only sufficiently to insure good drainage. Where it is possible to do so, the water should be carried off in drainage ditches.

### PLANTING.

*Time of planting.*—The two favorable seasons for planting are just before and immediately after the rainy season. Planting just after the rainy season usually produces the better crop. The station, however, made plantings every month when possible, and more frequently in some cases, to find the best time of planting for yield and for quality. The plantings which were made during the extreme dry seasons and during periods of excessive rains were largely failures. The station garden is located on a low, heavy clay soil that is retentive of water, and this probably accounts in part for the large percentage of failures during the rainy season. A large part of the lowland area of the island, however, is of this type of soil.

*Sowing the seed.* Air, heat, moisture, light, and food are required for plant growth. Only the first three are needed for the germination of seed. This climate is warm enough to germinate



seed at any time of the year. Moisture is a variable factor and seed should not be planted when the weather is too dry or when heavy rains are continuous. A good general rule to follow in planting vegetable seed is to cover it to a depth of about twice its diameter and firm the soil down well after planting. In some cases the depth of sowing may vary with the kind of seed and condition of the soil when planted. Usually the larger the seed and the drier the soil, the deeper it should be planted. In a light sandy or sandy loam soil seed can be planted deeper than in a heavy clay soil, because the germinating plant can force its way up through such soil with less effort. Since clay soil also holds water better than does sandy soil, the seed need not be planted so deep in it, especially in the dry season.

*Number of plants per acre.*—One acre contains 43,560 square feet, or forms a square a little less than 209 feet on all sides. One hectare is 2.47 acres, or nearly two and one-half times as large as 1 acre. The number of plants required per acre, with correct planting distances between plants and rows, is given in the following table:

*Plants required to plant an acre at different distances.*

Dis- tance be- tween rows.	Dis- tance be- tween plants in rows.	Num- ber of plants re- quired to the acre.	Dis- tance be- tween rows.	Dis- tance be- tween plants in rows.	Num- ber of plants re- quired to the acre.	Dis- tance be- tween rows.	Dis- tance be- tween plants in rows.	Num- ber of plants re- quired to the acre.	Dis- tance be- tween rows.	Dis- tance be- tween plants in rows.	Num- ber of plants re- quired to the acre.
<i>Inches.</i>	<i>Inches.</i>		<i>Inches.</i>	<i>Inches.</i>		<i>Inches.</i>	<i>Inches.</i>		<i>Inches.</i>	<i>Inches.</i>	
6	6	174,240	24	24	10,890	42	42	3,556	72	12	7,260
8	8	98,010	36	6	29,040	48	12	10,890	72	24	3,630
12	6	87,120	36	12	14,520	48	24	5,445	72	36	2,420
12	12	43,560	36	18	9,680	48	36	3,630	72	48	1,815
18	6	58,080	36	24	7,260	48	48	2,722	72	60	1,452
18	12	29,040	36	30	5,808	60	12	8,712	72	72	1,210
18	18	19,360	36	36	4,840	60	24	4,356	84	84	889
24	6	43,560	42	12	12,445	60	36	2,904	96	96	680
24	12	21,780	42	24	6,222	60	48	2,178	108	108	537
24	18	14,520	42	36	4,148	60	60	1,742	120	120	435

*Number of plants per row.*—The proper distances of planting, both in the row and between rows, depend upon the room required by each plant and the means of cultivation. Some plants, as for example the radish, can be placed close together, while others, such as beans, require more room. Tomatoes and other bushy plants require considerable space for best development. When the plants are to be cultivated by hand they may be planted much closer than when an animal-drawn cultivator is to be used. The following table gives the quantity of seed or the number of plants required for a row 100 feet long, distances for plants between rows and between plants in rows, and the depth of planting the seed or plants.

Gardeners' planting table.

Kind of vegetable.	Seeds or plants required for 100 feet of row.	Distances for plants to stand.			Depth of planting.
		Rows apart.		Plants apart in rows.	
		Animal cultivation.	Hand cultivation.		
		Feet.	Feet.	Feet.	Inches.
Acelga.....	1 ounce.....	3	1½	½	1
Amargoso.....	75 to 100 seeds.....	4	4	4	2
Arrowroot.....	50 to 60 plants.....	3	3	1½-2	2-6
Asparagus.....	1 ounce; 35 plants.....	3	3	1½-2	6-8
Beans:					
Cowpea.....	½ pound.....	3	2	2	2
Kentucky Wonder.....	do.....	3	1½	½	1-1½
Lima.....	¾ pound.....	3	1½-2	¾	1-2
Fijoles.....	½ pound.....	3	1½	½	1-1½
Seguidillas.....	¼ pound.....	3	3	3	1½
Cerebillas.....	½ pound.....	3	3	3	2
Beets.....	2 ounces.....	3	1½	¾	½
Cabbage.....	35 plants.....	3	3	1½	2-6
Calabaza.....	¼ pound.....	6-10	4-10	4-10	2
Carrots.....	½ to 1 ounce.....	2½	1-1½	¾-¼	½
Cassava.....	25 cuttings.....	4	4	4	4-6
Chard.....	1 ounce.....	3	1½	½	1
Chayote.....	10 to 25 fruits.....	4-10	4-10	4-10	2-4
Collards.....	¼ ounce.....	2½-3	1½	1½	1½
Condor.....	1 ounce.....	5	5	5	1
Cucumber.....	½ ounce.....	5	5	5	½
Eggplant.....	35 plants.....	3	3	3	2-6
Horse-radish.....	35 cuttings.....	3	3	1½	6-8
Lettuce.....	100 to 120 plants.....	3	1½	¾-1	1-3
Do.....	½ ounce.....	3	1½	½-¾	1
Mint.....	50 cuttings.....	3	2	1½	2
Muskmelon.....	½ ounce.....	5	5	5	½
Mustard.....	¼ ounce.....	2½	1½	¾-¾	1
Okra.....	1½ ounces.....	3	3	1½	2
Onion.....	1 ounce seed; 200 sets.....	2½	1½	¾-½	1
Papaya.....	10 plants.....	10	10	10	6-12
Parsley.....	¼ ounce.....	4-5	1-1½	¾-¼	1
Patola.....	½ ounce.....	4-5	4-5	4-5	1
Peas.....	1 pound.....	2½-3	1½-2	¾	2
Pechay.....	200 plants.....	1½	1½	½	2-6
Pepino.....	½ ounce.....	5	4	4-5	1
Peppers.....	½ ounce seed.....	3	1½-2	1½	1
Do.....	65 plants.....	3	1½-2	1½	2-4
Pigeon peas.....	¼ pound.....	5	3-4	3-4	2
Plantain.....	12 to 15 plants.....	8	8	8	6-12
Pumpkin.....	¾ ounce.....	6	6	6	2
Radish.....	1 ounce.....	1½	1½	¾	1
Roselle.....	35 plants.....	3	3	3	2-6
Spinach.....	1 ounce.....	1½	1½	½-¾	1
Squash.....	½ ounce.....	4	3	3	2
Sweet corn.....	¼ pound.....	3½	2½	3	2
Sweet potatoes.....	65 to 100 cuttings.....	4	3-4	1-1½	4
Taro.....	25 to 50 cuttings.....	4	2-4	2-4	3-6
Tomatoes.....	½ ounce; 30 plants.....	3-4	3	3	2-6
Turnip.....	½ ounce.....	1-1½	1-1½	¾	1
Watermelon.....	1 ounce.....	6	6	5-6	1
Yam.....	35 cuttings.....	4	3	3	6
Yam bean.....	¼ pound.....	3-4	3	¾-¾	2

Flats or seed boxes.—A shallow box for raising seedlings is called a flat, a seed box, or a germinating box. Some gardeners plant all seed in the field direct, but certain vegetables do better when they are grown in seed boxes and later are transplanted. A beginner will find it to his advantage to use seed boxes, since conditions for germination can be more easily controlled in them than otherwise and the seeds can be protected from ants, which are very troublesome in some soils and carry away newly planted seed. Plants can be more con-



veniently and easily watered in seed boxes than in the field; they can be better protected from the beating rains, which would injure them were they in the field; and the length of time required for growth in the field is lessened considerably, in some cases by several weeks. All this means less labor on the part of the person who cares for the plants. The seedlings in the seed boxes may be transplanted whenever conditions are favorable. Only the most vigorous and healthy plants should be moved.

A seed box is very easily made and may be of almost any size. It should be made with cracks or holes in the bottom for drainage. Very convenient seed boxes can be had by splitting or sawing lengthwise kerosene boxes on which the covers are nailed. Each box will make two shallow flats. Holes should be bored in the bottom of the boxes for drainage. Some boxes are still larger and are raised from the ground by legs which are set in shallow pans or tin cans filled with water or kerosene to keep ants from reaching the seed (Pl. II, fig. 1).

It is very important that good soil be placed in the seed boxes. Fine, mellow soil, which has been well sifted before planting and firmed down after planting, gives the best results. A rich sandy loam is preferable to other soils. However, when it can not be had there can be substituted a heavier soil that has been lightened by the use of well-rotted manure until the proper texture is secured. The seeds are best sowed in rows that are about 2 inches apart. Better results are obtained when the seed boxes are partly shaded and protected, especially while the plants are small and tender. This can be done by placing plaited coconut leaves on frames which are raised over the seed boxes. Up until the time the seed germinates the soil in the boxes should be kept moist, but not saturated. After germination the water should be applied only when the plants actually need it. Too frequent applications are likely to cause damping-off, a disease the causal organism of which attacks the young plants at the surface of the ground and causes them to fall over and die. Watering often and lightly tends to make the plants shallow feeders and weak seedlings; it also causes them to develop a spreading root system, which makes difficult the work of transplanting. A fairly heavy watering once in a while is probably the best means of application where there is danger of damping-off.

*Thinning.*—Seedlings which have been sown too thick in seed boxes should be carefully thinned out when they are an inch or so high. The roots of the remaining plants should not be disturbed any more than is absolutely necessary. The seedlings can be removed with the point of a knife blade or other small instrument and transplanted to other boxes or to bamboo pots. Field plantings also

should be thinned when the plants are too crowded to make a quick normal growth. Seed is frequently planted thickly, and later the plants are thinned to insure a perfect stand. Thinning is too often neglected by the farmer who thinks he will obtain a greater yield by crowding plants in a row or hill. Different plants require different distances, but to secure a good-sized, healthy plant it should be given plenty of room.

*Transplanting.*—Only those plants which are strong and stocky and have well-developed roots and leaves should be transplanted. Gardeners sometimes transplant several times to secure this hardy type of plant, the young seedlings being removed from the seed boxes to joints of bamboo, which are filled with earth and have holes in the bottom for drainage (Pl. II, fig. 1). After they have been transplanted for the first time and have fully recovered from any effect of the change, the seedlings should be allowed to harden off. This is done by placing the pots under a bamboo or a coconut-leaf shelter furnishing about half shade. These plants become hardy and when transplanted to the field show little sign of wilting.

Field planting is preferably done on a rainy or cloudy day, because the plants are less likely to wilt than would be the case were they transplanted on a hot, clear day. In case this kind of weather does not occur, the plants should be set out in early morning or late afternoon. Before they are removed the soil in the seed boxes should be thoroughly soaked with water, so that the plants can be transplanted with as little injury as possible to the roots. A larger number of plants than can be set out in a short time should not be removed, and those removed should be kept shaded and moist until they are transplanted. In setting out, the seedlings should be placed at the same depth at which they stood before transplanting. The soil should be well pulverized and well firmed around the roots after transplanting. In order to reduce transpiration and wilting, some of the tender leaves should be removed from the plants.

*Shading.*—Some vegetables, especially in the dry season, grow better when they are partly shaded than they do when not shaded. The effects of hot weather are largely counteracted by shading, and good stands are made possible when irrigation can be had. Halves of coconut husks, pieces of bamboo, sections of banana leaves and federico (*Cycas circinalis*) make excellent shade for newly transplanted seedlings. Coconut leaves are used to shade the whole plot by being spread singly on a light frame, which is raised high enough from the ground to enable the gardener to get under to cultivate and harvest the vegetables. Split bamboo laid about 2 or 3 inches apart is also used.



## CULTIVATION.

The principal reasons why the garden is cultivated are to keep down weeds, loosen the soil, and conserve moisture during the dry season. The soil must be stirred at frequent intervals if the best vegetables are to be produced. If the garden is given frequent cultivation, there will be no trouble in keeping down weeds. This point is well worth considering, because weeds grow quickly and throughout the year in Guam. Weeds compete with the vegetables for plant food in the soil. They rob the soil of fertility, use the moisture and space belonging to the crop, and often cause the plants to become weak and spindling. Moreover, they frequently harbor disease and insects which attack the growing plants.

Loosening the soil enables the plant roots to spread out and secure more food; stirring the soil breaks down soil particles, and, by the increased action of water and air, makes the plant food available. In the dry season cultivation prevents the soil from becoming hard and cracking, and in the rainy season, if given at the proper time, it keeps the soil from becoming compacted and puddled. Cultivation helps to conserve moisture during the dry season, and tends to stop evaporation at the surface of the ground. Evaporation has been found to be most rapid on compacted soils and less so on the cultivated ones.

The garden should be cultivated as soon after rains or irrigation as the soil is dry enough to keep it from being sticky. Sandy soil can be cultivated when very wet, but heavy clay soils in most cases should not be worked when wet. However, during the rainy season, it is often necessary to work even the heavy soils. In Guam, when cultivation is followed by rain, as is usually the case during the wet season, the soil does not seem to be injured as it is in the States. Some such work, as pulling weeds by hand, may be necessary, especially in the rows between the plants. A field is generally sufficiently cultivated if the ground has been made fairly loose and weeds are not allowed to grow.

Most of the gardens of Guam are cultivated by hand. All the land, with the exception of the smaller gardens, should be prepared with a plow. Plowing with a carabao is much faster and easier than doing all the work with a fosiño, and the ground is left in better shape. However, every gardener should have a plow, a fosiño, and a machete. Other tools that are helpful to the gardener include a rake, a spade, a hoe, a wheelbarrow, a line long enough to reach across the garden for making straight rows, and one or two sprinkling cans. A hand cultivator should be included in the equipment, because

various attachments can be fitted to it, and it thus enables the gardener to do many kinds of work. (Pl. III, fig. 1.)

*Irrigation.*—Water is essential for growing plants. It is only during the dry season that the Guam gardener needs to concern himself with supplying sufficient water for his vegetables. No well-defined rules can be drawn up for applying water to the garden. In some districts, where the water supply is ample, small home gardens can be watered direct from the pipes of the water system in the villages. However, most farmers have to get water wherever they can, and often may have to carry it from small streams near by. During times of drought, vegetables can be grown only when they receive plenty of water (Pl. II, fig. 2). One heavy irrigation is worth several light irrigations, which cause the roots to remain close to the surface of the ground. Water should be applied only when it is needed, and then the soil should be well soaked. This irrigation should be followed by a light or shallow cultivation as soon as the surface ground is dry enough to work.

*Rotation.*—Rotation of crops, or the planting of different successive crops, on the same land for a series of seasons should be practiced in gardening work in Guam. The moist, warm climate of this tropical island is very conducive to plant diseases and pests. Many vegetables, after growing on the same ground for a number of seasons, become so severely attacked by bacterial or fungus diseases that they fail to produce satisfactory crops. The same kind of vegetable should, therefore, not be grown continuously on the same area. In this way the danger of infection from the soil or plant material left in the soil is minimized, as the fungi or bacteria die when the host plant is absent.

In all true rotations a legume is grown to furnish nitrogen and to improve the soil. In the small garden the legume may include any of the beans, but in the larger garden it probably would be more profitable to grow cowpeas or velvet beans as a cover or green-manure crop in one part of the rotation. Rotation is also of advantage in that it causes all the available plant food in the soil to be utilized. Some plants have many fibrous roots which feed close to the surface of the ground; others have roots that go nearly straight down and feed in the deeper soil; others again are nothing more than enlarged roots or tubers. These plants all feed at different depths, and, consequently, when rotated, fully utilize the available plant food in the soil. In a crop rotation the vegetables are planted in more favorable locations each season so far as plant food is concerned. Crops which are similar in nature should not be used to follow each other in rotation. Root crops, as for example radishes, beets, onions, or sweet potatoes, can be followed by leaf crops such as lettuce, kale, or acelgas, which in turn can be followed by vine crops, or tomatoes and





FIG. 1.—VEGETABLES GROWN IN GUAM.

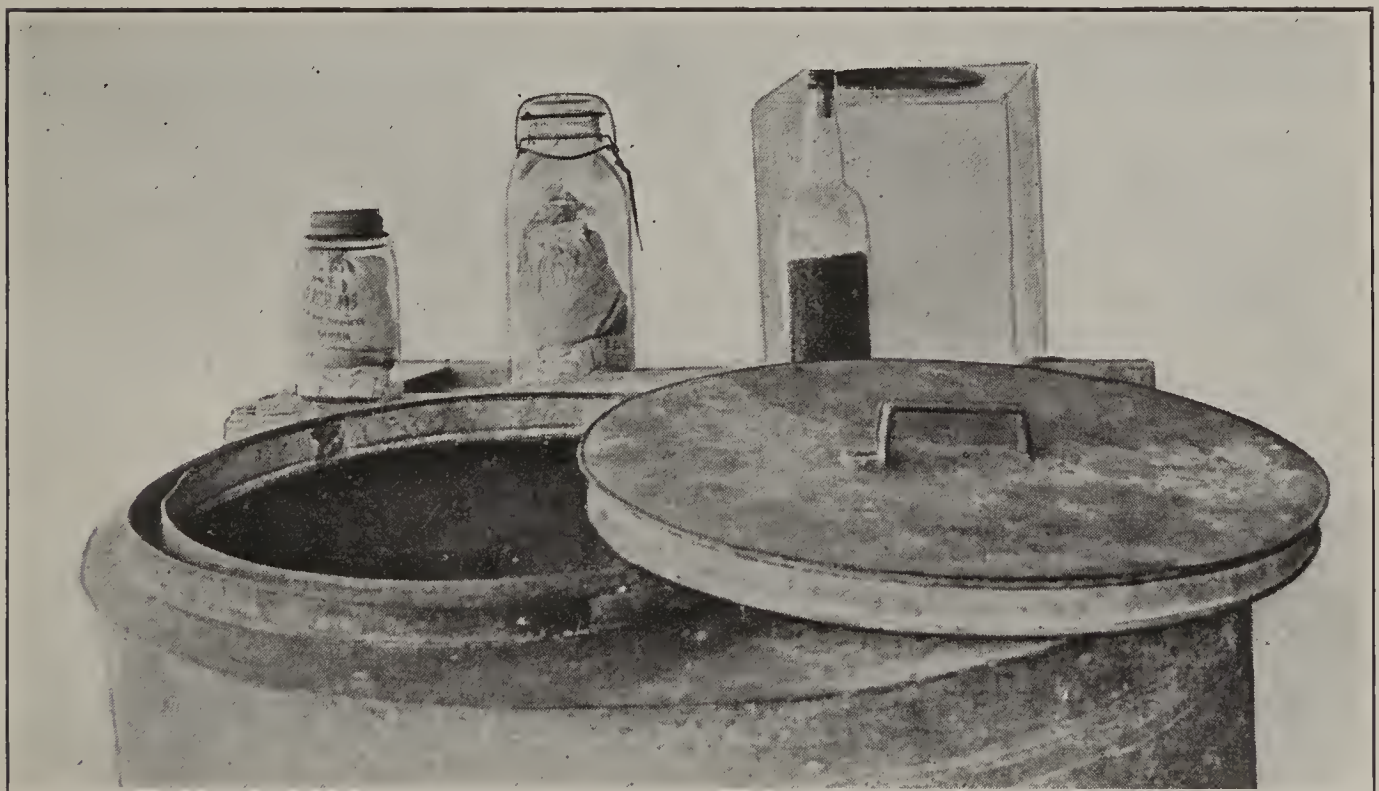


FIG. 2.—CONTAINERS FOR STORING SEED.





FIG. 1.—SEED BOX AND BAMBOO POTS.



FIG. 2.—IRRIGATING GARDEN BEFORE PLANTING.



eggplants, and later by beans or cowpeas, the vines of which should be turned under.

### FENCES AND WINDBREAKS.

In Guam it is necessary that every garden be inclosed by a fence of some kind. It should be of such a nature as to keep out chickens and pigs or other stray animals. It is recommended that a fence which is strong enough to keep out carabao be used to protect the crops. Bamboo makes a good fence, but it does not last long. Camachile when planted very closely makes a splendid fence or hedge, and also serves as a windbreak when it is allowed to grow high. Probably the best fence of all, though rather an expensive one, is the woven wire fence. However, for use in permanent gardens it is cheaper than is some structure which would have to be replaced yearly. The expense entailed in building a good fence will be amply compensated for within a short time by the reduction in crop losses due to stray animals.

Strong winds are of frequent occurrence in Guam during certain parts of the year. To protect growing plants from damage during these periods it is necessary that the gardens be surrounded by windbreaks, which may consist of trees, shrubs, bamboo, or buildings. The pigeon pea affords a very efficient protection and is one that gives some return as a crop. It is planted around the garden in double rows 3 feet apart and makes a thick, heavy growth, reaching a height of 10 to 15 feet (Pl. XIII, fig. 1). After the first year it bears large quantities of peas, which can be used for food either in the green or dry state. Its only disadvantage is that after two or three years it loses its effectiveness and must be replanted. Cassava can be used in a similar way.

### PLANT ENEMIES.

Both insect pests and plant diseases are likely to attack garden plants, and, under favorable conditions, may destroy the entire crop within a few days or weeks. The gardener should, therefore, not only know how to plant and care for the garden, but he should be able to recognize pests and diseases and protect the plants from them. Preventive measures are best of all. The best and most economical measures are cultivation, drainage, and crop rotation. Insects and diseases attacking one kind of plant usually do not attack another. A vigorous plant on account of its ability to resist attack is not so likely to suffer as is the less hardy plant. Diseases are often carried over from one crop to the next on old decaying vegetable matter. Old vines, stalks, and other refuse of plants that have shown disease or signs of disease or insect attack should therefore be burned.

INSECT PESTS AND FORMULAS FOR CONTROL.<sup>1</sup>

From the standpoint of the gardener, insect pests may be classed as biting or chewing, and sucking. Biting insects eat leaves and other parts of plants. Sucking insects puncture the plant with their mouth parts and drain the plant juices in much the same manner that mosquitoes take blood from a person. Each kind of insect requires a different treatment for control and extermination. Remedies used for control are known as insecticides. These are classed as stomach poisons and contact poisons. A biting insect can be killed by an insecticide which is sprayed on the leaves and is taken into the stomach along with other food. Sucking insects may be killed by spraying plants with some mixture which, by its nature, will stop up the breathing pores of the insects, or prevent motion.

## STOMACH POISONS.

*Lead arsenate.*—The insecticides generally used for biting insects contain arsenic in some form. Paris green is used to some extent, though lead arsenate is given the preference because it is less expensive, equally as effective, and easier to apply. It is sold either in the powdered or the paste form. Both are very good and can be used in solution with a spray pump. When a spray pump can not be had, the dry or powdered form of lead arsenate should be used. One part lead arsenate should be thoroughly mixed with seven parts corn meal, ashes, or fine, dry dust, and sprinkled on the plants. When used as a spray, the lead arsenate should be mixed with water, 4 pounds of lead arsenate being used to 100 gallons of water.

Twice as much by weight of the paste form should be used as in the case of the powdered form. When only small amounts are needed at a time, about two-thirds (one and one-third for paste) of an ounce is added to a gallon of water. In case scales can not be had, the right proportions are about 3 tablespoonfuls or 10 level teaspoonfuls of the powdered form to 1 gallon of water. Plants having a waxy or smooth surface hold the spray only in large drops which are not effective for the whole plant. An even distribution can be had by adding a pound of soap or a quart of coconut oil to the spray for each pound of lead arsenate. The correctly applied spray covers the plant with a thin film and leaves a thin white coat.

The number of sprayings to be applied during the season depends upon the kind of pests present and the prevailing weather conditions. The poison is soon washed off by frequent rains. The plants should be sprayed at each infestation and even more frequently, if necessary, where more than one brood of insects are present during the

<sup>1</sup> Since nearly all insecticides and fungicides are poisonous, they should be kept out of the reach of children and animals.



growing season. The solution should be thoroughly mixed and dissolved before it is put into the spray pump. Before it is used the spray should be strained through a piece of cloth so as to remove all pieces large enough to clog the nozzle of the pump.

*Poison bait.*—Mole crickets, cutworms, and a few other insects do great damage by working at night. The following method of dealing with these insects is taken from a Porto Rican circular:<sup>2</sup>

For cutworms: Mix  $\frac{1}{2}$  pounds of Paris green or London purple, or 1 pound of white arsenic, with 25 pounds of meal, middlings, or, preferably, bran.<sup>3</sup> Stir a quart or two of cheap molasses into a gallon of water and moisten the bran, stirring thoroughly, until it makes a stiff mash. Do not make the mixtures too thin. Apply a day or two before setting out the plants, laying small heaps every 2 or 3 feet in the row; if the plants are already out, place a small heap near each. Apply as near nightfall as possible. Keep poultry and hogs out of treated fields.

For changas (mole crickets): Mix thoroughly  $2\frac{1}{2}$  to 3 pounds of Paris green or London purple with 100 pounds of low-grade flour. This is of special value in tobacco plantings and in gardens.

To protect valuable plants, such as tobacco and tomato, the mixture should be placed in a shallow trench, made with the finger, around and not less than 3 inches from the plant.

To exterminate the mole cricket from a given area supply the mixture broadcast. Keep the land to be treated free of all vegetation for at least a week before applying the poison. At dusk scatter the mixture in small piles at the rate of 250 to 300 pounds to the acre. After four or five days the changas will have eaten the poison and planting can be done.

#### CONTACT POISONS.

Aphids or plant lice, mealy bugs, scale insects, and other larger kinds of insects which suck the juice from plants can be killed by contact insecticides provided the insect is touched with the spray. The spray should, therefore, be thoroughly applied to every plant. As a general rule, foliage in the Tropics can stand a more concentrated solution of sprays all the year without injury than can the same class of plants in the States. A plant has been sufficiently sprayed when it is thoroughly wet. The solution should not, however, be allowed to run down the trunk or collect in large drops. The most common of the contact remedies are kerosene emulsion, tobacco decoctions or extracts, and soap solutions.

*Kerosene emulsion.*—The standard solution used by the Guam Experiment Station is made up of  $\frac{1}{2}$  pound of common soap, 1 gallon of water, and 2 gallons of kerosene. The soap is dissolved in boiling water. To the hot, soapy water, after it has been removed from the fire, the kerosene is slowly added, the solution being stirred vigor-

---

<sup>2</sup> Porto Rico Sta. Circ. 17 (1918), p. 9.

<sup>3</sup> It is suggested that coconut or copra meal be tried in Guam as bran and flour are not usually obtainable.

ously while the kerosene is being poured in. The mixture is further emulsified by pouring the solution from one container to another or by pumping it for 10 to 15 minutes through the spray pump, with the nozzle removed, directing the spray back into the solution. The liquid should form a white foamy mixture and show no trace of free kerosene on the surface of the water. This is called a stock solution and it will keep indefinitely. For spraying purposes it should be diluted in the proportion of 1 part to 10 parts water. It should be applied with sufficient force to reach all insects and cover their bodies.

*Tobacco extract.*—Probably the only drawback to homemade tobacco extracts is their uncertain strength. The most commonly used preparation is made by steeping (not boiling) tobacco stems for several hours in enough water to cover them, or by allowing the stems to remain in cold water for 24 to 36 hours. This is usually at the rate of 1 pound of stems to 1 gallon of water. The decoction should be diluted when used by adding 2 or 3 times as much water as of the solution, or until it is the color of weak tea. The addition of a little liquid soap or soap solution to the tobacco decoction makes it spread better on the plants.

Several brands of highly concentrated nicotin sulphate solutions now on the market are effective and convenient for use. Their principal drawback, however, is their expenes. Most of these solutions are put up in tin containers which soon rust in this climate. Unless the contents are removed they will be spoiled, resulting in great loss.

*Soap solutions.*—The soap solution is a good spray for soft-bodied insects in the plant house or on house plants. It can be made by dissolving 1 pound of soap in 4 gallons of water, straining, and applying with a brush or small syringe.

*Ant spray.*—The following formula for ant spray has been taken from a circular published by the Porto Rico Station.<sup>4</sup>

*Carbolic acid emulsion for ants.*

Water_____	gallon__	1
Soap _____	pound__	1
Crude carbolic acid, 100 per cent (dark)_____	pint__	1

Dissolve the soap in the water and add the carbolic acid, churning as for kerosene emulsion. This is the stock and does not thicken as kerosene emulsion does. It must be diluted 1 to 48 (1 pint to 6 gallons of water) and at this strength can safely be used on foliage.

Whenever the nests of ants can be located, this is a most effective remedy against them. Insert the end of the pump tube with the nozzle removed in the nest and flood it with the emulsion. Puddle the nest with the foot. After

<sup>4</sup> Porto Rico Sta. Circ. 17 (1918), pp. 10, 11.



three or four days any surviving ants will have shown evidence of their work and the process should be repeated. More than two treatments are seldom necessary. The procedure as outlined has been successful whenever carried out.

*Repellants.*—A repellant is a material used in such a way as to prevent insect attacks. Those most commonly used at the experiment station are powdered tobacco leaves, lime, and naphthalene. Tobacco leaves should be powdered as finely as possible when they are dry and then scattered around the plants. They are often effective in keeping away aphids and other small insects. A small amount of lime sprinkled around plants or over seed beds helps to keep away slugs and the common, hard-shelled millipede. These insects seem to prefer moist and sour soils, conditions which the lime corrects to a certain extent. Lime added to stored seeds has been found to absorb excess moisture, prevent deterioration in vitality, and protect against weevil injury. Small quantities of naphthalene when placed in seed containers keep away insects. Large amounts, however, may effect the germinating power of the seed.

#### FUNGUS DISEASES AND REMEDIES FOR THEM.

Plant diseases are usually caused by low forms of plant life called fungi or bacteria. These live on the tissues of plants and cause the roots, or other parts of the plant, to lose color, wilt, rot, and gradually die. Fungi produce small microscopic bodies called spores, which are blown about in the air until they find a resting place. When conditions are favorable they germinate and grow upon other plants. Remedies used for the prevention or control of fungi are called fungicides. For some diseases, compounds containing certain amounts of copper make the best fungicides. In other cases sulphur is better. These remedies should be applied either before or as soon as indications of the disease appear.

*Bordeaux mixture.*—This mixture is probably more commonly used than any other because it is effective for many plant diseases. However, instructions should be carefully followed when it is being prepared so that the solution will not injure the plants. Bordeaux mixture is made at the experiment station by adding 1 pound of copper sulphate (bluestone) and 1 pound of unslaked lime to 10 gallons of water. These amounts can be changed in the same proportions to any amount desired. Stock solutions can be prepared of the copper and lime, which are mixed whenever large amounts are needed, or when frequent sprayings are to be made. Copper sulphate can be purchased in quantities and will keep indefinitely. Lime should be secured fresh from the kiln before it has a chance to become air-slaked.

The copper sulphate is placed in a coarse cloth sack and hung in 5 gallons of water until it is all dissolved. This solution should be kept in wooden or earthenware containers because the copper sul-



phate corrodes metal containers and causes a loss of the copper in the solution. The unslaked lime should be slaked with a little water in a separate container. The water should be added a little at a time until the lime is slaked, and then enough be added to make the solution up to 5 gallons. In this condition each mixture can be kept as stock solution for an indefinite period. When prepared for use the two solutions should be mixed together by pouring them at the same time into a wooden tub, barrel, or earthenware container, such as a large tinaja, and stirring constantly. After the spray is mixed the solution should be tested for excess copper by holding a bright knife blade in it for a minute or two. If copper is deposited on the blade, more lime should be added to the solution; if the blade remains bright, the mixture is of about the right strength. The solution should be strained and used at once because it soon loses its adhesive power. When used on plants having very tender foliage the mixture should be diluted further by adding 5 to 10 gallons of water.

*Sulphur*.—Dry powdered sulphur (called flowers of sulphur) has been found to be effective in combating powdery mildew on cucumbers, muskmelons, and squashes. It is applied by dusting on and around the plants, either by using a powder gun, or by placing the sulphur in a bag on the end of a stick and shaking it among the leaves. This is best done early in the morning when the dew is still on the plants and there is no breeze. The warm sunshine causes the sulphur to liberate gases which kill fungi.

#### ANIMAL PESTS.

Large numbers of crabs and rats infest the island of Guam. These do great damage by attacking nearly mature fruit, in which they make a hole just large enough to extract the seeds. Both pests are difficult to control.

*Crabs*.—The crab damages plants by making burrows to and under them. Poisons can be used to kill them where they exist in large numbers, and bamboo crab traps can be set to catch them if they are in small numbers. All the crabs in a burrow can be killed by placing a teaspoonful of carbon bisulphid on some cotton, which is pushed into the burrows. The entrance of the burrows must be stopped up, so as to prevent the gas from escaping. This treatment will be effective unless the ground is too porous.

Phosphorus<sup>5</sup> and corn meal mixtures are commonly used in Porto Rico for combating crabs. These mixtures should contain only 1 to 3 per cent of phosphorus, as higher percentages are apt to cause spontaneous fires, which may be destructive to buildings or standing crops.

Stir a stick of phosphorus into a 5-gallon can half full of corn meal and water. Bring the mixture to a boil over a fire and stir constantly until the

---

<sup>5</sup> Porto Rico Sta. Circ. 17 (1918), p. 29.

phosphorus is entirely mixed. With enough water added to prevent undue smoldering, the mixture is ready for use. It is preferable to introduce it into crab holes rather than to leave it exposed where poultry or other animals might find it.

*Rats.*—These pests can be kept under control, to a certain extent, by traps made of bamboo. A garden which is surrounded by cleared or cultivated land is not as likely to be infested with rats as one which is situated in the immediate vicinity of brush and trash. The Bureau of Biological Survey, United States Department of Agriculture, found barium carbonate to be one of the best rat poisons. Other poisons that are recommended are strychnine and arsenic. The following extracts are taken from a publication<sup>6</sup> of the United States Department of Agriculture.:

Barium carbonate: One of the cheapest and most effective poisons for rats and mice is barium carbonate. This mineral has the advantage of being without taste or smell. It has a corrosive action on the mucous lining of the stomach, and is dangerous to larger animals if taken in sufficient quantity. In the small doses fed to rats and mice it would be harmless to domestic animals. Its action upon rats is slow, and if exit is possible they usually leave the premises in search of water. For this reason the poison may frequently, though not always, be used in houses without disagreeable consequences.

Barium carbonate may be fed in the form of dough composed of 4 parts of meal or flour and 1 part of the mineral. A more convenient bait is ordinary oatmeal with about one-eighth of its bulk of the mineral, mixed with water into a stiff dough. A third plan is to spread the barium carbonate upon fish, toasted bread (moistened), or ordinary bread and butter. The prepared bait should be placed in rat runs, about a teaspoonful at a place. If a single application of the poison fails to kill or drive away all the rats from the premises, it should be repeated with a change of bait.

Strychnine: Strychnine is too rapid in action to make its use for rats desirable in houses, but elsewhere it may be employed effectively. Strychnia sulphate is the best form to use. The dry crystals may be inserted in small pieces of raw meat, Vienna sausage, or toasted cheese, and these placed in rat runs or burrows; or oatmeal may be moistened with a strychnine sirup and small quantities laid in the same way.

Strychnine sirup is prepared as follows: Dissolve a half ounce of strychnia sulphate in a pint of boiling water; add a pint of thick sugar sirup, and stir thoroughly. A smaller quantity may be prepared with a proportional quantity of water and sirup. In preparing the bait it is necessary to moisten all the oatmeal with the sirup. Wheat and corn are excellent alternative baits. The grain should be soaked overnight in the strychnine sirup.

Arsenic: Arsenic is probably the most popular of the rat poisons, owing to its cheapness; yet our experiments prove that, measured by the results obtained, arsenic is dearer than strychnine. Besides, arsenic is extremely variable in its effects upon rats; and if the animals survive a first dose it is very difficult to induce them to take another.

Powdered white arsenic (arsenious acid) may be fed to rats in almost any of the baits mentioned under barium carbonate and strychnine. It has been used successfully when rubbed into fresh fish or spread on buttered toast. An-

---

<sup>6</sup> Lantz, D. E. U. S. Dept. Agr., Farmers' Bul. 369 (1909), pp. 14, 15.



other method is to mix 12 parts by weight of corn meal and 1 part of arsenic with whites of eggs into a stiff dough.

An old formula for poisoning rats and mice with arsenic is the following, adapted from an English source:

Take a pound of oatmeal, a pound of coarse brown sugar, and a spoonful of arsenic. Mix well together and put the compound into an earthen jar. Put a tablespoonful at a place in runs frequented by rats.

Ripe papayas with the seed still adhering to the pieces would, no doubt, make an effective bait in Guam because the rats are very fond of papaya and papaya seed. Toasted raw coconut meat is also liked by them and can be used in the native traps as bait.

#### SPRAY APPARATUS.

There are a large number of spray pumps on the market, all of which are probably good. (Pl. III, fig. 2.) The parts that come in contact with the liquid should be of brass or brass lined, because this metal is strong and will not rust and corrode in Guam if it is given proper attention. In all cases the parts should be thoroughly cleaned and dried after using. The nozzle should be a good one capable of delivering a fine mist. The Vermorel type of nozzle has given good results at the experiment station. The bucket pump has been found very satisfactory for use in the home or small-sized garden. The knapsack sprayer is very convenient for the larger gardens, since it is a compressed-air outfit and can be carried on the back. Such an outfit leaves both hands free to direct the spray and to lift the leaves of the plants when necessary. The air pressure also provides a more steady stream of spray than is secured by hand pumping.

#### DETAILED CULTURAL DIRECTIONS AND EXPERIMENTAL DATA.<sup>7</sup>

The following account gives in some detail cultural directions for the various garden crops in Guam and the results of some of the experimental work that has been conducted by the station.

##### ACELGA (*Beta cyclo* or *B. vulgaris cyclo*).

Acelga is also known as chard, Swiss chard, leaf beet, white beet, spinach beet, and sea kale. It is closely related to the common garden beet, but produces a small woody root instead of a fleshy one. The leaves are largely cooked whole as greens, or used to flavor soups and stews. Sometimes the large, thick leafstalks and midribs are cooked as salad, being used as a substitute for spinach or asparagus. The outer leaves are removed from the plant and used as above, but the inner ones should be left to continue growth for the production of

---

<sup>7</sup> In the experimental work the plats have varied from one two-hundredth to one-fiftieth acre in size and in some cases they have been even as large as one-fourth acre. During the dry season irrigation was practiced to a certain extent.

more crops later on. The first leaves are generally ready for harvesting within five to eight weeks after the seed is planted, depending upon weather conditions.

Soil in which acelga is grown should be fairly heavy and well-drained, and thoroughly prepared before the seed is planted. If large amounts of humus or decaying organic matter are incorporated with the soil the growth of the plant will be hastened and the leaves produced will be large and tender. Seed should be sown about 1 inch deep in rows 18 inches apart, and the plants should be thinned to 6 inches apart in the row when they are about 2 inches high. When plantings are made at intervals of several weeks a supply of leaves will generally be available for use throughout the year.

#### AMARGOSO (*Momordica charantia*.)

Amargoso, also known as paria or ampalaya, is grown in many of the gardens of Guam. It is a slender vine that grows to best advantage when given support. It bears green fruits, which are from 6 to 8 inches long, warty in appearance, and turn yellow when nearing maturity. This vegetable is used as a salad after it has been soaked in water to remove its bitter taste. It is often cooked as a vegetable when green, being used with the tops of the vine.

Amargoso seed can be planted at any time of the year. It is commonly planted 2 inches deep in hills 4 feet apart. The vines begin bearing in three or four months and continue to bear for some time. Cultivation consists largely in keeping the soil free from weeds after the plants are well started on the trellis or fence.

#### ARROWROOT (*Maranta arundinacea*).

Locally the arrowroot is known as arorú. It is commonly grown in the gardens of Guam for the starch yielded by its fleshy roots. Arrowroot is propagated either by means of young shoots which are detached from the parent stool or by division of the rhizomes. It is planted about 6 inches deep in rows 3 feet apart and each plant should be spaced from 18 to 24 inches apart in the row. Generally the plant requires from 9 to 12 months to mature. If it is planted in May before the rains start, it can be harvested during the dry season.

Arrowroot grows on nearly all kinds of soil, but the roots develop most fully in soil that is neither too hard nor too full of rocks. It should be given cultivation similar to that given corn until the plants are large enough to shade the ground. Yields of 1½ or 2 tons of roots per acre were secured at the experiment station on very poor, rocky soil. The roots yielded 11 per cent of a high-grade starch as extracted by the crude Chamorro method.



ASPARAGUS (*Asparagus* sp.).

Asparagus does not do very well in the tropical climate of Guam and produces only small and spindling sprouts. However, it can be raised if it is given the proper care. Plants can best be secured if seed is sown in boxes or flats and later transplanted to the garden. The plants should be set about 18 to 24 inches apart in the rows, which should not be closer than 3 feet.

The soil for growing asparagus should be greatly enriched by applying manure. Trenches 2 feet deep and the same in width should be nearly filled with well-rotted manure and the plants set in the soil over the manure. Top-dressing of manure when applied yearly gives good results. No shoots should be cut during the first year, and few the first part of the second year, but during the last part of the second year and in the third year a great many can be cut if at intervals the plants are allowed to grow. The tender young shoots should be cut when they are a little larger than a pencil.

BANANA (*Musa sapientum*).

The banana in many regions is usually considered a fruit, but in Guam it is largely used as a cooked vegetable. It is one of the staple food crops of the island and grows in all the gardens and on all the ranches or farms. The banana should be planted on well-drained soil in a location that is protected from wind. New soil is generally preferred for this plant. It is a shallow feeder for its size, and therefore needs considerable mulching and fertilizing. Plants are propagated by means of offsets or suckers, which are removed from the base of the parent when the suckers are about 2 feet high. The old stumps are occasionally cut 3 feet above ground and dug out. In this way they may be kept in good condition for several days, or even for a few weeks. They take root and grow rapidly from the center when set out. Bananas are planted from 8 to 12 feet apart each way. Weeds and trash that are removed from the plats should be piled around the base of the growing plants from time to time to furnish them with mulch and decaying organic matter. This system of fertilizing is the only one that is used by the Chamorro farmer, and the banana is the only crop which is fertilized in Guam. The plants produce fruit in 10 to 15 months after they are set in the field, according to the variety grown. Production is continuous after that because the suckers produce fruit regularly.

## BEANS.

Both American and tropical varieties of beans are grown in Guam, where they rank among the staple food crops (Pl. IV). They are largely used before they reach maturity and are picked in a green

state. One or more varieties of beans are found in practically every garden at all seasons of the year, some of them doing well at any season. They grow on all kinds of soil, but do best on a well-drained loam. Of a large number of beans that were imported from the States, Kentucky Wonder, a reddish-brown kidney variety, largely used as a string or green snap bean; Henderson's Bush, a bush Lima bean; one or two varieties of cowpea; and Pencil Pod Black Wax, a wax bean, are the best varieties that were tested by this station. Of the tropical or native beans, the cerebilla, fijole, seguidilla, mungo, chochomeca, and an unnamed variety are all commonly grown in Guam. If some of these varieties are planted every few weeks, a continuous supply of green beans can be had throughout the year. (Pl. V, fig. 1.)

KENTUCKY WONDER BEAN (*Phaseolus* sp.).

The experiment station has distributed seed of the Kentucky Wonder bean to nearly every man, woman, boy, and girl living on a farm in Guam. On account of its ease in growing, its high yields, long periods of production, and good edible qualities, this variety of pole bean is well liked by the people of Guam. However, many of them have yet to learn how to properly plant and care for this bean and in what seasons to grow it.

Kentucky Wonder is planted at all times of the year, but during the rainy season, when the ground is literally soaked with water, it shows a higher percentage of failures than at any other time. During the wet season plantings should be made upon raised seed beds or ridges to provide drainage. The chances for a good crop are then better than when plantings are made on ground that is not properly drained. Sandy soils produce better crops during the rainy season than do the heavier soils. A fertile loam soil is most desirable for all-the-year-round plantings.

Kentucky Wonder beans should be planted from 1 to 1½ inches deep, the seeds being from 4 to 6 inches apart in the row. For hand cultivation a convenient distance for rows is 18 inches apart, but if a cultivator is to be used the rows should be made at least 3 feet apart. The plants should be provided with supports on which to climb when they are small or just beginning to vine. These can be made of bamboo or other small poles 6 to 8 feet long. The soil should be kept free from weeds by frequently cultivating it with a cultivator or a fosiño. Cultivation should be discontinued after the plants start to blossom because it is likely to injure the roots, and weeds or other volunteer growth can be pulled up by hand.

The green beans are in best condition to be eaten when the pods do not bend or tear, but break with a snap. The first beans are



ready for picking in from 7 to 9 weeks after planting. The most favorable months for planting to secure large yields are May, February, December, and March. The lowest average yields were secured from the June, July, August, and April plantings. In all tests applications of commercial fertilizers and barnyard manure to the land greatly increased the yield of string beans (Pl. VI, figs. 1 and 2).

LIMA BEANS (*Phaseolus lunatus*).

Lima beans have made very satisfactory growth in nearly every test carried on during 10 or more years by the experiment station. The variety known as Henderson's Bush was superior to all other varieties tested and is recommended for planting because it is well adapted to Guam soil and climatic conditions (Pl. V, fig. 2). It can be planted all the year round, but produces the highest yields when there is no rain at blossoming time.

Unless good drainage is provided during the wet season the crop is almost certain to be a failure. For high yields clean cultivation is essential, and a well-tilled loam soil is preferred to other soils throughout the year. Seeds are planted 1 or 2 inches deep, according to the amount of moisture in the soil, and 4 inches apart in the rows. For hand cultivation the beans do well if they are planted in rows 18 to 24 inches apart. As this variety of bean is of the bush type the plants do not need any support.

Lima beans are ready for harvesting within 10 or 12 weeks' time. They should be picked for eating just before the pods ripen and while the beans are still tender. In this stage they are easily shelled. When dry beans are desired, picking should be delayed until the pods ripen. Frequent pickings are necessary in this case to prevent partial destruction of the beans by the larva of a moth, which feeds within the pod when harvesting is delayed. Much damage can be avoided by promptly shelling and drying the seeds and by immediately placing them in insect and moisture proof containers.

Since plantings of Lima beans occupy the ground for about five months of the year, two crops of beans should be secured from the same area every year. It is suggested that plantings be made even more frequently so that there will be no lapse of production for table use between the last harvest of one crop and the first harvest of another. At the experiment station the highest average yields for any one month covering a period of 5 years was 5,312 pounds of beans, which were produced from November plantings. The months of September, October, November, and June were the most favorable for planting to secure the best results, while the months of March, April, July, and August were the most unfavorable for planting for yields.



PENCIL POD BLACK WAX BEANS (*Phaseolus* sp.).

The Pencil Pod Black Wax bean has been found superior to 10 or more other varieties of wax beans that were grown in comparative tests at the experiment station. All were much lower yielders than the Kentucky Wonder string bean or the Lima bean. The Pencil Pod Black Wax did well and received favorable mention the first years it was tried, but within recent years it has been practically a failure at the station.

Wax beans should be planted from 1 to 2 inches deep in rows 18 to 24 inches apart. Good drainage should be provided for the plants during the rainy season and irrigation during the time of severe droughts. Cultivation is largely done by hand, a hoe, fosiño, or small-wheel hoe being used for the purpose. Keeping down weeds and maintaining a well-tilled surface is all the care that the plants need.

COWPEAS (*Vigna sinensis*).

Cowpeas have recently become popular in Guam as a garden vegetable. The Blackeye and Whippoorwill varieties are extensively planted, but the latter variety is the more popular of the two owing to its higher yields. No trellis or support is needed for these plants, although when they are provided the yield of beans is greatly increased. The cowpea is one of the best dry-weather beans because it withstands drought better than does any of the other varieties of beans commonly grown.

Cowpeas are planted 2 inches deep in rows 3 feet apart and in hills 24 to 30 inches apart, or in drills 8 to 10 inches apart. They grow well on all the soils of Guam, and are planted in the poorest places in the station garden in order that the soil may be improved after the beans are harvested and the vines are turned under. Green beans may be harvested in from 60 to 90 days after planting. The beans are ready to be picked before they are fully developed and while they are still tender and brittle.

CEREBILLA (*Dolichos lablab*).

Two kinds of lablab, hyacinth, or bonavist bean, locally known as cerebilla, are grown for food in Guam (Pl. IV). One is called the red cerebilla on account of its distinctive reddish-purple vines, the color of which extends around the margin of the seed pod. The other is called the white cerebilla on account of its light-colored foliage. They make a vigorous and viny growth and produce the most seed when they are allowed to climb upon supports. The cerebilla stands dry weather remarkably well and continues to blossom

and fruit as long as conditions are favorable. The beans are eaten in the green pod as snap beans. The cerebilla grows very well during all seasons. On account of its heavy foliage the plant is usually grown along fences, low-growing shrubs, and old walls, so that costly supports for the heavy vines will not be necessary. Two or three seeds are planted in hills not less than 3 feet apart.

FIJOLE (*Vigna sinensis*).<sup>8</sup>

The fijole is a tropical variety of the cowpea and is known as Chinese asparagus bean, twining cowpea, sítao (in the Philippines), yard bean, and also the fathom bean on account of the length of its pods. (Pl. IV). This variety is grown on the same kind of soil and in the same manner as the Kentucky Wonder bean.

The pods of the fijole are from 18 to 40 inches long and make good string beans when they are young and tender. The beans are spaced about 1½ inches apart in the pod, are only medium in size, and of kidney shape, and a brownish color. The fijole yields exceptionally well and is worthy of a place in the Guam gardens. The beans are not as highly prized as the Kentucky Wonder beans, however, and are very susceptible to attacks by aphids, especially when the pods are small. The average length of time from planting to first harvest was found to be 55 days. The duration of production was 33 days, making the average length of time this crop occupied the land 88 days.

SEGUIDILLA (*Psophocarpus tetragonoloba*).

Locally this bean is known as seguidilla, but in other places it is called giant seguidilla, or more commonly the winged bean. Its pods are four-sided and winged with four longitudinal frills, one being on each corner (Pl. IV). The pods are tender, succulent, and free from stringiness, and are cooked in a manner similar to the way string beans are cooked. When cold they can be sliced and used as salad. Many people prefer them to other varieties of beans.

The seeds of the seguidilla are planted about 1½ inches deep in hills which are at least 3 feet apart each way. Strong supports or a trellis should be provided for the beans to climb. The seguidillas are hardy plants and are not very exacting as to their requirements. Probably their greatest drawback is the length of time elapsing before they produce edible pods. The average time in three tests conducted by this station (from planting until first harvest) was 178 days, after which they continued to produce for 29 days. Each crop occupied the ground on an average of 207 days.

---

<sup>8</sup> The fijole is not the frijole grown in the southwestern part of the States.



MUNGO (*Phaseolus aureus*).

The mungo is called the mung or green gram bean in many places, but it is known as the mungo or moñggo in Guam. Of the tropical beans, it is the only upright bushy variety that is commonly grown by the Chamorro people. All the others are either the running or climbing varieties. The plant grows to a height of about 3 feet. Its small, slender beans are grown in clusters at the end of the branches, where the seed ripens unevenly and shatters badly. For this reason the beans have to be harvested several times to secure all the seed. They are used in many different ways and are considered a very nutritive and wholesome vegetable. The seeds are boiled, baked, and pickled, or sprouted for salad. The mungo does not make the heavy yield that is secured from other varieties, but the beans are in great demand.

The mungo grows on all kinds of soil from the heavy, red clays to the sandy beach soils. However, while it grows on all of these with varying degrees of success, it makes its highest yields when planted on loam soils. The beans are planted about an inch deep in rows that are from 24 to 36 inches apart and the plants are spaced 4 to 6 inches apart in the rows. They mature seed in from five to seven weeks after planting, and the whole crop is often removed in less than three months. The mungo has been planted broadcast at the experiment station and plowed under for green manure with very satisfactory results when it was not more than 18 to 24 inches high.

CHOCHOMEKO (*Phaseolus lunatus*).

The chochomeco or Patani bean, which grows in Guam (Pl. IV), is a species of Lima bean. The variety is badly mixed and the seed has no definite color, both solid and speckled colors being present. A black bean which has been found in the mixtures is reported as poisonous. These beans should be removed from the mixtures before the chochomeco is planted. A white bean, which is locally known as judias, has also been found among the chochomecos. It very much resembles the white Lima bean and is edible. The experiment station has never received any reports concerning injurious effects from eating this bean. The chief value of the chochomeco lies in its effectiveness as a cover crop, which produces green beans during the dry season.

The chochomeco is planted and cultivated in the same manner as the cowpea. It bears pods during the dry season, but yields less than does the bush Lima bean. The beans are hard to pick, being scattered on the vine instead of produced in clusters at the ends of the branches. This plant forms an effective cover crop for a period of nearly two years and makes a good rotation crop for the garden.

## HALF-LONG FIJOLE.

Another bean that has been giving very satisfactory results as a green snap bean is an unnamed variety growing at the experiment station. The white seeds have a regular marking of red which covers one-quarter of the bean at one end and side. In growth they much resemble Kentucky Wonder. The bean pods, however, are longer than Kentucky Wonder and shorter than the fijole pods, being about 10 or 12 inches long (Pl. IV). The seeds are fairly close together in the pod. This variety has been called the half-long fijole at this station to distinguish it from the other varieties of fijole.

The half-long fijole is planted, cultivated, and harvested in the same manner as the Kentucky Wonder. The first beans are ready for harvesting in 60 to 70 days and the vines continue to produce for about 40 days longer. At the station the average yields obtained during eight tests were 6,000 pounds per acre of snap beans on unfertilized land. The half-long fijole has given the highest yield of any bean that was tried at this station and is worthy of further trial in the gardens of Guam.

CORN (*Zea mays*).

Beets are not generally grown in Guam because the climate is considered to be too warm for them. However, they have been grown at the experiment station at the end of the rainy season during the cool weather. (Pl. VII, fig. 1.) This vegetable requires a heavy, moist soil such as is found in the lowlands, but one that is not soggy. The ground should be deeply plowed before planting to provide a place in which the roots can develop. The roots should be kept growing rapidly so that they will not become woody.

Beet seeds are sown very shallow, less than 1 inch deep and fairly thick. When the plants are 2 inches high they should be thinned out, leaving plants from 4 to 6 inches apart. The rows should be made about 18 inches apart. It is sometimes advisable to grow the seed in flats for small plantings for home use, and later, when the plants have four leaves, to transplant them to the field. The root is the edible part of the older plant. It can be pickled or boiled and used as a vegetable. The tender tops of the young plant can be used as greens.

Some young beets are ready to be harvested in about 9 weeks, and the harvest season may extend over two months. Beets that were grown on soil to which commercial fertilizer had been added gave a much larger yield than did those which were grown on unfertilized land.

At certain times of the year the tops of the beets are attacked by caterpillars, which defoliate the plants. The larvæ, which are called





FIG. 1.—GARDEN TOOLS. 1, HAND CULTIVATOR; 2, WATERING CAN; 3, FOSIÑOS; 4, MACHETE; 5, RAKE; 6, HOE; 7, GRUBBING HOE; 8, MATTOCK.

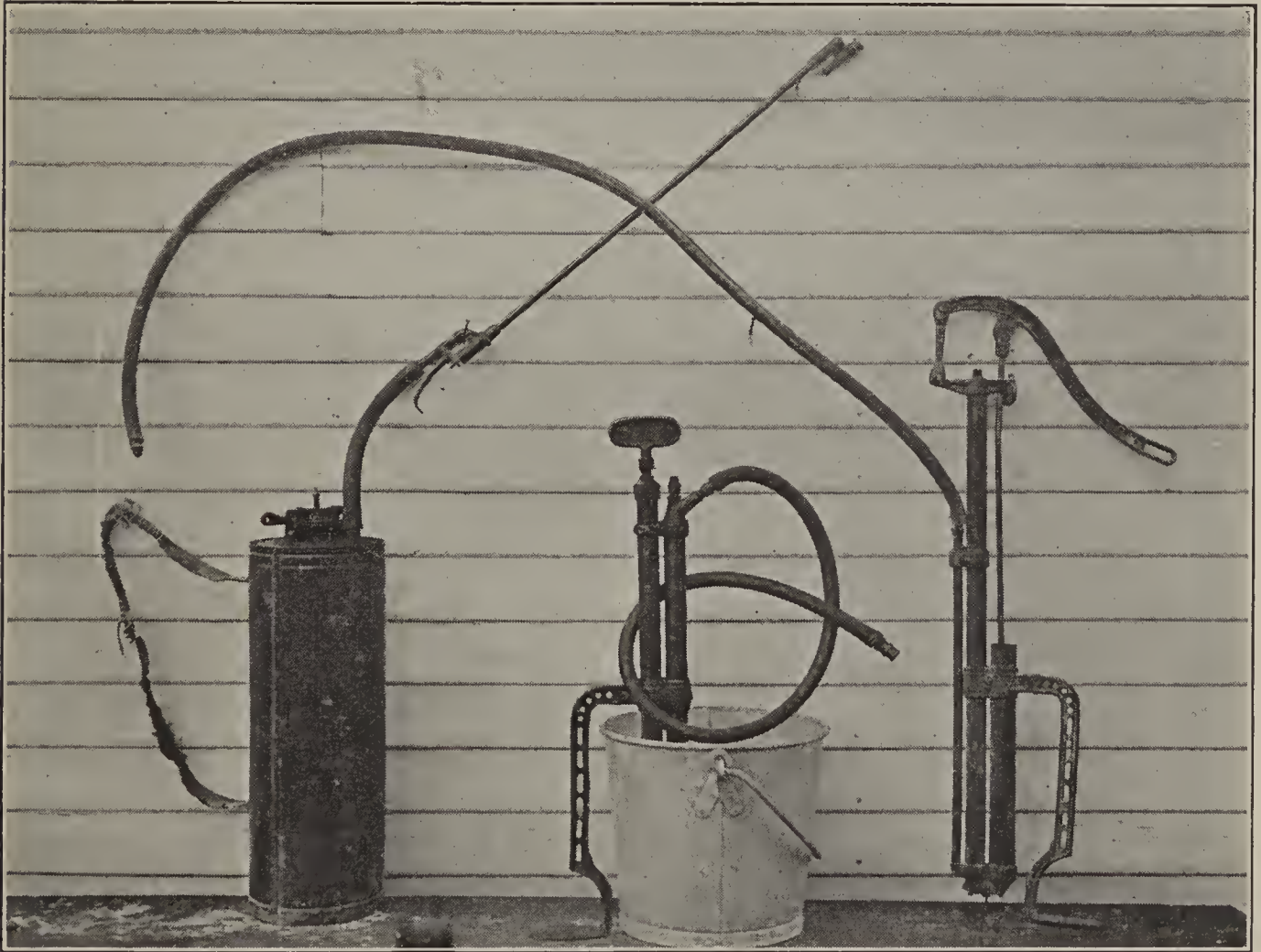
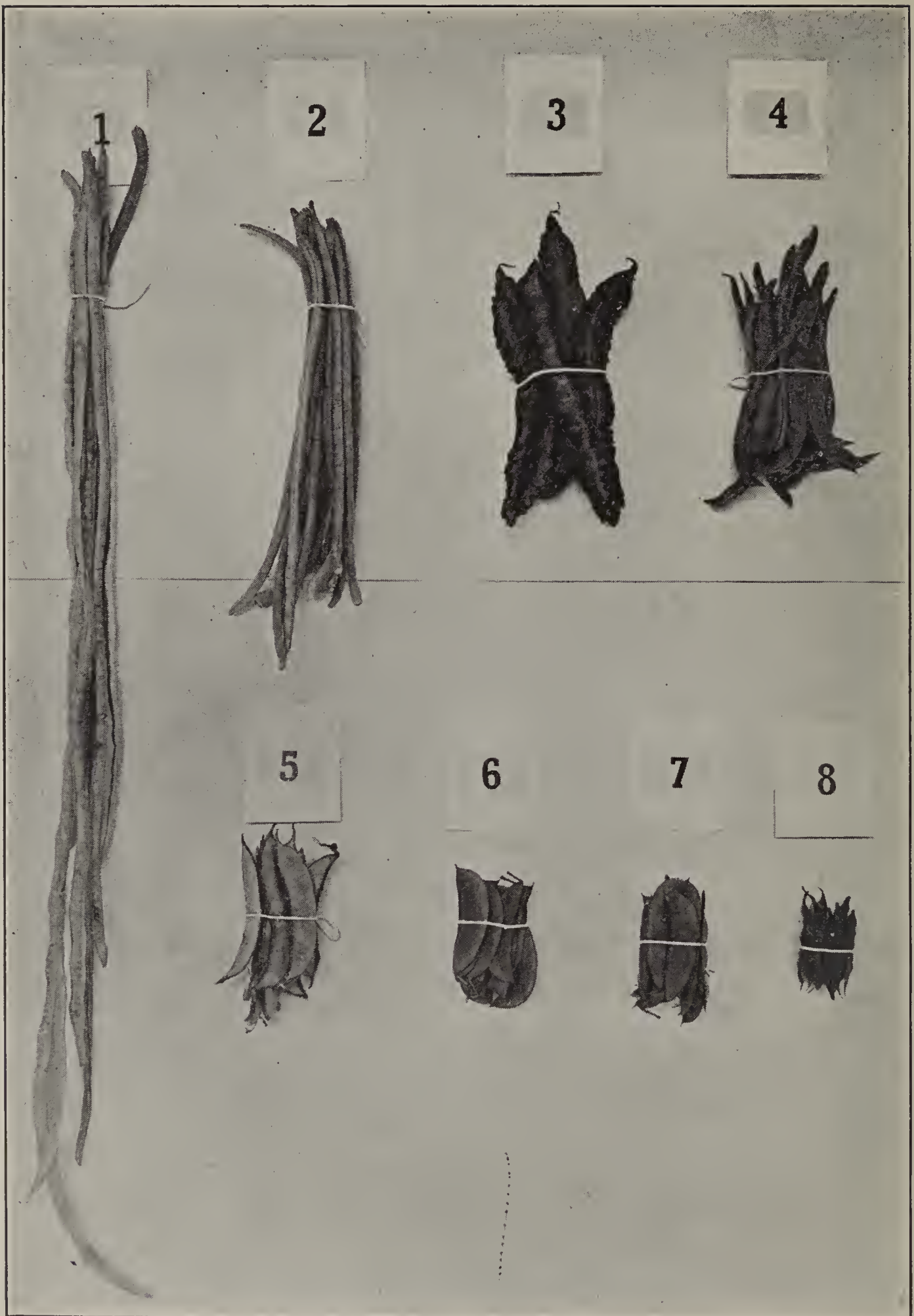


FIG. 2.—SPRAY PUMPS. LEFT, KNAPSACK SPRAYER; CENTER AND RIGHT, FORMS OF BUCKET SPRAY PUMPS.





TYPES OF BEANS GROWN IN GUAM.

1, Fijole; 2, Half-Long Fijole; 3, Seguidilla; 4, Kentucky Wonder; 5, Cerebilla; 6, Lima;  
7, Chochomeco; 8, Pigeon Peas.





FIG. 1.—SUCCESSIVE PLANTINGS OF BEANS.



FIG. 2.—HENDERSON'S BUSH LIMA BEANS.





FIG. 1.—KENTUCKY WONDER BEANS, NOT FERTILIZED.



FIG. 2.—KENTUCKY WONDER BEANS, WELL FERTILIZED.



webworms, appear very suddenly and may destroy the entire crop within a few days unless checked immediately. Spraying with lead arsenate greatly reduces the injury. The caterpillars have been identified as the beet webworm (*Hymenia fascialis*) and the cabbage webworm (*Hellula undalis*).

#### CABBAGE (*Brassica oleracea*).

Tests with cabbages have not been very successful at the experiment station owing to climatic conditions, failure of the plants to head at times, and to injurious insects. Cabbage does not grow very large in Guam, but when the plants do head they are of very good quality. The seed should be planted in seed boxes, and when the plants are 4 inches high they should be transplanted on a rainy or cloudy day. The plants are placed in rows 3 feet apart and spaced 18 inches apart in the row.

Cabbage plants require a well-drained, rich soil having sufficient moisture to keep them growing rapidly and to make the heads crisp and solid. Stable manure is a good fertilizer for cabbage. The plants can easily be placed in holes which are made with a sharp-pointed stick, each plant being set in the ground slightly deeper than it stood in the seed box. The plants should be set down to the first leaf, the soil should be well firmed around the roots, and they should be well watered unless the soil contains sufficient moisture at the time of transplanting. Frequent cultivation should be given the soil to keep the plants growing rapidly. Plantings made from September to the last of November do better than those made at other times. The first cabbage should mature in from 10 to 15 weeks after the plants are set in the field.

Cabbage is considerably damaged by insects unless especial care is taken to prevent infestation. The cabbage worm is commonly found in Guam and eats the inner as well as the outer leaves of the cabbage head. These worms are difficult to control when they are present in large numbers, although they can be easily picked off by hand when they first appear. Lead arsenate is one of the best remedies for them. However, when it is to be applied after the head has become fair sized, care should be taken to see that the cabbage is carefully trimmed and washed because the remedy is poisonous.

#### CALABAZA (*Lagenaria vulgaris*).

The calabaza, or bottle gourd, is one of the cucurbits. It has less flavor than some of the squashes, and is generally planted around clearings and near fences. A few plants will furnish enough fruit to last the family the year around.

Seeds of the calabaza are planted in hills several feet apart. The plants are thinned to one healthy plant per hill. The first calabaza was harvested at this station two months after planting. Seven days later the plants were destroyed to make room for other vegetables, but they yielded at that time at the rate of 1,500 calabaza, weighing 3,155 pounds to the acre.

#### CARROTS (*Daucus carota*).

Carrots (Spanish, *zanahoria*) have been grown very successfully at the experiment station for the last 10 years. Of the varieties tried, the short, stump-rooted variety known as Oxheart has given the best results. (Pl. VII, fig. 2.) The orange-colored roots can be cooked as a vegetable or used in soup. The quality of the carrots has been all that could be desired when they were kept growing rapidly, being sweet, tender, and very crisp.

Carrots grow best in rich, loose, friable loam soil. The seed germinate very slowly, and a good stand is secured only with great difficulty unless the soil is in suitable condition. This is true more especially during the extremely hot, dry weather or during periods of heavy rains. The seed should be planted one-half inch deep and fairly thick in the row. When the plants are well started they should be thinned to 2 or 3 inches apart. Rows may be made from 12 to 18 inches apart. The roots, which can be harvested as they are needed, become woody if they do not grow rapidly or if they are left in the ground too long after growth has ceased. Plantings which were made during November, October, August, and December gave the highest yields, while those that were made in April, June, July, and September gave the lowest yields.

#### CASSAVA (*Manihot manihot* or *M. utilissima*).

Cassava, locally known as mendioka, is found growing in most of the gardens of the island. Its fleshy, tuberous roots are used for making meal, starch, and cassava, or tapioca flour. The starch when properly prepared by heating forms the tapioca of commerce. The fresh roots are used as a cooked vegetable and make a cheap tropical food. During times when the island has been devastated by typhoons, such as have occurred three or four times within the last 20 years, the roots of the cassava were found to be uninjured, while other crops were largely destroyed. The cassava is therefore considered a most important crop for times of food shortage. Its roots can be left in the ground for some time without becoming injured other than fibrous.

Cassava seed is produced in Guam, but the plants are propagated by cuttings from the parent stem, each cutting being from 6 to 10



inches long. These are planted about 4 feet apart each way. Cassava does well on most soils, but develops its best root system on sandy or loam soils that are well drained. On account of the ease with which it can be cultivated and its ready propagation by cuttings, this vegetable is easily grown at comparatively small cost. The roots can be used in from 8 to 12 months and will keep even longer if they are left in the ground. After being harvested they should be peeled, sliced, and dried to keep for an indefinite period. Yields at the experiment station on heavy, unsuitable soils have been from 4,162 to 15,631 pounds per acre.

Cassava is generally divided into the bitter and sweet varieties having little or no distinguishing characters in the vegetative portion or roots of the plant. Three distinct types of cassava have been found at the station. The natives recognize each type especially by its edible qualities. These types are called the yellow, white, and red mendioka, from the color of the inside of the root or from the color of the skin next to the heavy outer coat of the peel. (Pl. VIII, fig. 1.) There are also certain differences in the stems and petioles, but all the leaves are apparently alike. For some time after they are harvested the roots of the yellow and red varieties are very similar, the red color in the second coat of the red mendioka being largely lost after the root is exposed to the air. Cases of poisoning from eating cassava have occasionally been reported to the station, and it is known that the roots of certain varieties contain small amounts of hydrocyanic (prussic) acid. It is thought that most of the sweet varieties are free from this poison.

The yellow variety in Guam produces short, thick, bunched, brown roots, the inside of which are a decided yellow, shading to a lighter color at the outside edge adjoining the thick skin. This variety is cooked in very much the same way that the sweet potato is cooked and tastes like one while tender. No ill effects from eating this variety have been reported to the station.

The roots of the white cassava are long, slender, and very spreading. The inside is pure white, has a granular appearance and a decidedly starchy taste. The outer skin or peel is light in color and the second skin is pale pink. It is largely used as a starch plant and as a vegetable only after it has been well cooked.

Roots of the red variety are darker brown at maturity than those of the yellow variety. However, the only distinguishing characteristic that can be depended upon is the bright red color of the skin underlying the outer peel. This color is noticeable just after the roots are harvested. The natives never knowingly use this variety for food except in the form of starch. Prussic acid is removed from the roots by the repeated washings and dryings in the sun

during the process of starch making. This variety can be distinguished from other varieties by its stalk character. The stalk is large, dark green to purplish, and has very pronounced bracts at the base of its long, dark reddish-purple petioles, which shade to lighter red near the leaf blade. The upper part of the stalk is five-sided to a marked extent, and the petioles are longer on this variety than on the other varieties. The stalk of the yellow variety is green, fairly straight, tapering, and has a short, green petiole. The white variety has a rough, knotty, light-green stalk with bright red petioles, which are medium in length.

#### CHAYOTE (*Sechium edule*).

The chayote is a tropical plant which has been grown in Guam only in a limited way, owing, no doubt, to lack of knowledge as to how it should be used. It is a climbing plant closely resembling the squash and cucumber. It is a perennial and needs very little attention after it is once well established. It bears large numbers of greenish or white pear-shaped or rounded, deeply grooved fruits, which weigh from one-half to 2 pounds each (Pl. VIII, fig. 2). These are used in a manner similar to the summer squash and are usually cooked, being stewed in vinegar, fried, or otherwise.

The chayote contains only one seed, which protrudes from the end of the vegetable and is planted together with the fruit by being placed on its side and partly covered with soil. Supports should be provided for the vines to grow upon. The plants may be spaced 10 feet apart along fences or else allowed to grow on a trellis in the home garden. The vegetable matures in three or four months after planting and is edible any time after that. The vines will continue to bear for several years if they are given proper care and their foliage is not injured by mildew. This plant is not so well known as it should be, and for this reason it has not been appreciated. The chayote makes a large yield and after it is planted requires very little if any care for several months or years.

#### COLLARDS (*Brassica* sp.).

At the present time the collards plant is little known in Guam. It is a species of headless cabbage which withstands hot weather and is better adapted to the Tropics than cabbage. This vegetable requires the same kind of soil, care, and treatment as cabbage. Probably the best time for planting is from November until March. The plants continue to grow for several months if the leaves are picked off as they fully develop. After the large, tender leaves are removed, the naked, knotty stem continues to produce at the



top a cluster of leaves which make the plant resemble a small palm tree. This cluster is left at the top to protect the "heart" or growing point of the plant and to produce more leaves.

CONDOR (*Benincasa cerifera*).

The condor is sometimes called the ash pumpkin or wax gourd, but in Guam it is known as the kondot. It produces yellow blossoms, and the fruit grows on a long vine in a manner similar to the cucumber. The fruit is shaped like a long watermelon, but is covered with a wax-like substance which gives it a whitish appearance. The half-grown fruits are cooked as a vegetable, generally being boiled with meats. The mature fruits are used for preserves and pickles.

Condor does better when it is planted on a loamy, well-drained soil, 3 or 4 seeds being planted about an inch deep in a hill. The rows should be 5 feet apart, and there should be the same distance between the hills. The best time to plant this vegetable is during the latter part of the rainy season, but it can be planted at any time of the year if irrigation is provided for it. The vines begin bearing in from 90 to 120 days, and if they are given proper care will continue to bear for several months. When the mature melons are stowed in a dry, shady place they can be kept for several months without spoiling.

CORN (*Zea mays*).

Sweet corn does not grow well in Guam. Good stands are easily secured, but the plants do not develop properly and die without producing ears. The ordinary white Guam corn has a very good flavor and grows so readily that it has become popular as a green corn and for "roasting ears." By planting at intervals of two, three or four weeks one can have fresh corn during the greater part of the year. When it is wanted in the green stage the corn should be harvested just before the kernels begin to harden, and while they are still tender and full of "milk." The corn has reached the proper stage of maturity when the milk pops out of the kernel upon firm pressure of the thumb-nail. Corn can be cooked on the cob after the shucks (husks) are removed from it, or the grains can be cut from the cob with a sharp knife and cooked.

Corn is planted on nearly all but the highest land in Guam. A moist, fertile loam, which can be easily tilled, produces the best crops. The land to be planted to corn is prepared by clearing and plowing, and cultivation for the most part should be done with animal-drawn implements. Three or four grains of corn are planted 2 inches deep in a hill, and the hills are about 3 feet apart in rows which are  $3\frac{1}{2}$  feet apart. The green ears are ready to be harvested in from 80 to 100 days, and the ripe corn in from 110 to 120 days.

Corn is severely attacked by a number of insects during the rainy season. Most of them can be controlled by sprays, but the cost of spraying after each of the frequent rains makes the method of control too expensive to be recommended. Plant lice, leaf-folders, and the European corn borer are serious pests at certain seasons. When the corn has been harvested the stalks should be burned as soon as they are dry. This is the only means of combating the corn borer. Diseases are not generally serious, although a green and white striping of the leaves occasionally occurs and the plants cease producing.

#### CUCUMBER (*Cucumis sativus*).

The Chamorros sometimes speak of the cucumber as the pepino (Spanish), a name which is also applied to other vine vegetables resembling the cucumber in some respects. The cucumber is used in many ways by the people of the island. After the fruit ripens it is boiled, baked, or fried, or used in stews or sauces. In the immature stage the fruit is sliced for salad or pickled whole. Cucumbers are very much liked by nearly all of the people in Guam.

The most suitable soil for growing cucumbers is a well-drained, rich sandy loam. Cucumbers will stand a great deal of moisture if they are given drainage. For this reason they can be grown more profitably in the rainy season than many of the other vegetables. They readily respond to large amounts of humus or organic matter in the soil. A good practice is to mark off into squares the area to be planted, making the rows 5 feet apart each way, and digging at each corner a hole into which well-rotted manure is placed and thoroughly mixed with the soil. This will cause a small mound to be formed, upon which 5 or 6 seeds should be planted one-half inch deep. Germination takes place in a few days and the growth is very rapid. After the plants have well started and have two well-developed leaves, they should be thinned to two or three vigorous plants to the hill.

Cross cultivation can be practiced until the vines have made considerable growth. If all the vines are trained in the direction of the rows, a small space will be left between each row, which will enable one to harvest frequently without stepping on the tender vines. The cucumber is harvested for pickling while the seeds are still immature and tender and the vegetable is not over 4 inches long; and for slicing from the time that it reaches this size until it has nearly fully developed. This vegetable is much less likely to be injured if it is cut from the vine than if it is pulled off. There is a material decrease in yield when cucumbers are allowed to ripen on the vine, because much of the plant's vitality is required to ripen the vegetable. Cucumber vines will continue to produce for some time if the cucumbers are harvested every two or three days.



Cucumbers begin to bear in from 50 to 60 days after planting. The average of 41 tests tried at the experiment station was 57 days, and the time from the first until the last harvest averaged 32 days. Several varieties were tried, but the Fordhook Famous variety gave the most satisfaction in all trials (Pl. IX, fig. 1). This variety yields well and produces a good, marketable cucumber which is well adapted for slicing, being long and not too slender. The young vegetables can also be used for pickles. The cucumber is practically a certain crop and can be planted at almost any time of the year. It produces exceptionally heavy yields of fine quality when it is planted at the beginning of the rainy season. The plants producing during the period of intense heat often have a large number of ill-shaped and immature fruits. During five-year tests the most favorable months for planting for high production were December, April, May, and June, and the lowest yields were obtained from plantings made in August, January, March, and November.

Both the powdery and downy mildews are serious diseases of the cucumber in Guam. The former is distinguished first by a yellowing of the leaves and later by the falling off of the older leaves near the center of the hill. The vine presents a dry, naked appearance at the base, although the tip continues to produce green foliage. The disease is most serious during the dry season. Sprayings with sulphur will control it. The downy mildew is recognized most readily early in the morning, when the leaves look as though they had been lightly dusted with flour. Downy mildew can be at least partly controlled by Bordeaux mixture.

#### EGGPLANT (*Solanum melongena*).

The eggplant, which is locally known by the Spanish name of *berengena*, is easily grown in Guam and produces heavy yields of excellent fruit (Pl. IX, fig. 2). It is an important garden vegetable in Guam. At the time the experiment station was established two varieties of eggplant were growing in Guam, one a small, round-fruited sort and the other a long, slender-fruited type of a light green color. Both were of inferior quality. The station introduced from the States seed of the New York Improved Spineless, which is a decided improvement over the native varieties. The New York Improved Spineless is large, dark purple in color, and of very good quality. The plants grow vigorously and with very little care.

The eggplant is very hardy, growing well in light sandy or heavy clay soil, although it makes its best growth in a light, rich loam. It withstands drought remarkably well and also makes good growth during the rainy season. The soil should be plowed deeply because the

plant is a deep feeder. Good drainage should be provided during the rainy season, as the fruits will rot and fall if the roots stand in water.

Seed of the eggplant is planted in flats or seed boxes or in bamboo pots and transplanted to the field as soon as the plants are large enough and conditions are favorable for transplanting. The plants are set 3 feet apart each way. Eggplant can be harvested any time after it is one-third grown up until the time it begins to ripen. Although this vegetable is edible while young, it should be allowed to develop fully before marketing. This vegetable should be picked after the seeds have well formed but before they have ripened, because it is worthless after the seeds harden. The stage for gathering can best be determined by the color of the fruit, which is lustrous while developing, the outside having a shiny purplish glow. It is ripe and ready for harvesting when it loses its luster and assumes a dull hue. When there is any uncertainty as to the proper time to harvest, several eggplants should be opened to determine the difference in maturity, which can be compared with the outside color.

Seed should be saved from the most vigorous and healthy plants producing large quantities of good vegetables. Eggplants which are selected for seed should be allowed to remain on the plants until they have fully matured. They should then be harvested, the outside pulp pared off, and the pulp placed in water for two or three days to ferment. The inside part containing the seeds should be quartered with a dull knife and cut into small pieces. After the seeds have been worked out of the pulp they should be thoroughly washed, spread out very thin on a screen, and allowed to dry as quickly as possible so that they will not sprout.

Usually the first New York Improved eggplants are ready for harvesting in about three months after transplanting and the native eggplants in about two months. The improved variety continues to produce fruit for about three months after it starts to bear, while the native varieties produce for only two months. Fruits which are produced during the dry season are uniformly of excellent flavor and texture. During the rainy season fewer eggplants set than at other times, and these have a tendency to rot before they are one-third grown.

#### HORSE-RADISH (*Cochlearia armoracia*).

Horse-radish (Spanish, *rabano picante*) is used as a relish or condiment for meats and fish and has a pungent odor and a biting taste. The root is cleaned and grated for use. This vegetable requires a rich sandy loam for growth, although it will do well in a heavier soil provided that a large amount of organic matter is added to





FIG. 1.—BEETS.



FIG. 2.—OXHEART CARROTS.

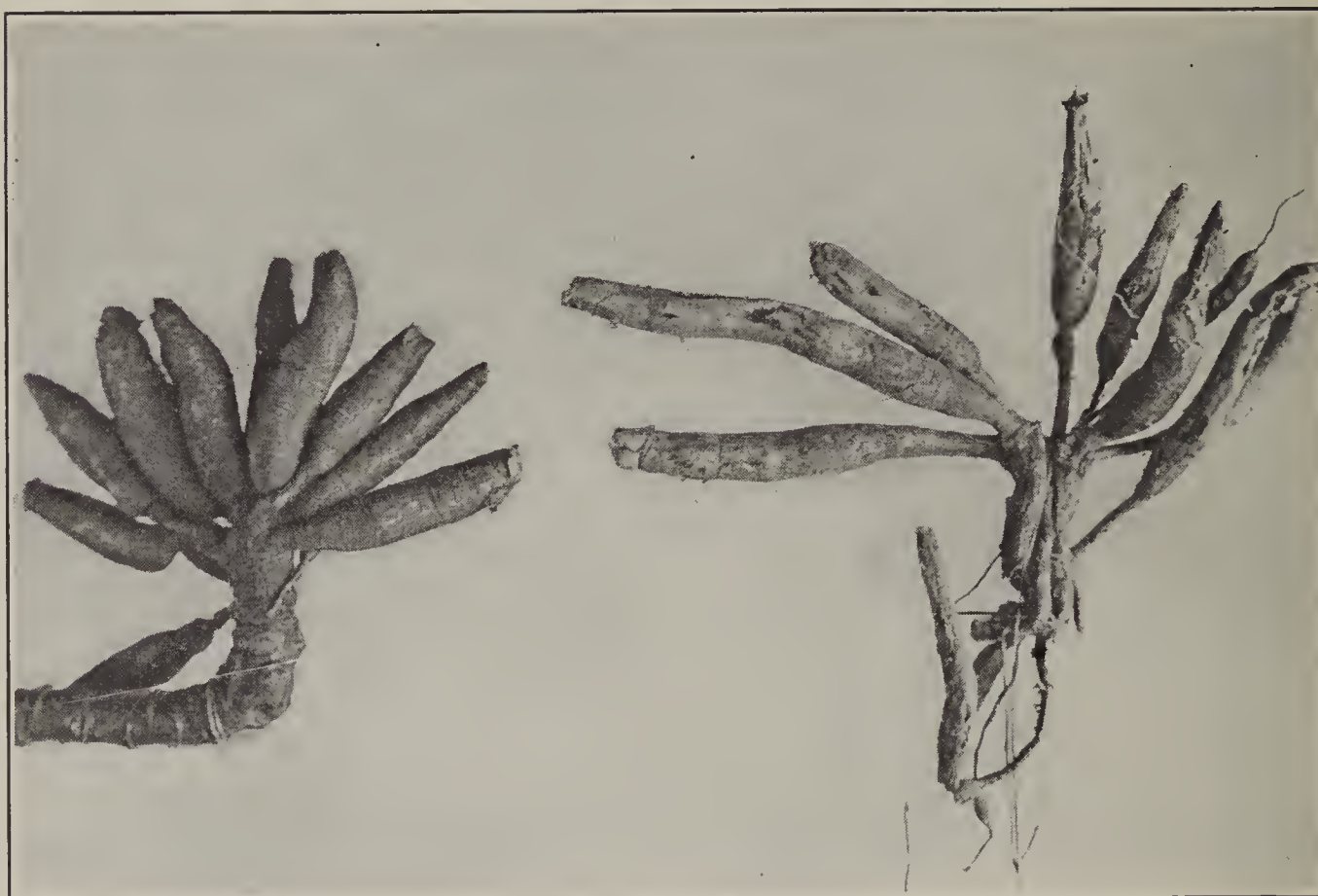


FIG. 1.—CASSAVA VARIETIES. LEFT, WHITE; RIGHT, YELLOW.



FIG. 2.—CHAYOTE FRUITS, BEGINNING TO SPROUT.





FIG. 1.—CUCUMBERS, FORDHOOK FAMOUS.



FIG. 2.—EGGPLANTS.





FIG. 1.—LETTUCE.



FIG. 2.—ONIONS.



the soil. It is planted from straight root cuttings 4 to 6 inches long which are set about 18 inches apart in rows 3 feet apart. The holes should be made deep enough to allow the cutting to stand upright and be covered with 2 or 3 inches of soil. Cultivation need not be often but it should be deep. Roots are harvested at any time after they are of sufficient size. The lateral roots are uncovered and cut off the main part of the plant. When dried, the roots will keep for an indefinite period.

#### LETTUCE (*Lactuca sativa*).

Lettuce may be grown in Guam very successfully provided that special attention is given to cultural directions. A rather heavy soil is suitable for growing this vegetable, but it must be well drained and rich to produce the best quality and largest yield of plants. Lettuce grows almost to perfection during the cool weather from November to January. It should be kept in rapidly growing condition by manuring, cultivating, watering, and draining the area devoted to it so that the leaves will be tender, sweet, and crisp. Slow-growing lettuce is never palatable and is almost sure to be worthless.

Ants are very fond of lettuce seed and have been known to carry away every seed that was planted. Nearly all the failures in lettuce growing, when good seed was planted in properly prepared beds, can be ascribed to the ants. When they are numerous, it is best to plant the seed in seed boxes, which are placed on a table or frame having its legs set in cans of water. If the plants are crowded in the box, they should be thinned out. After the plants are 1 or 2 inches high, or have put out four leaves, they can be transplanted to the garden with very little difficulty. Part of the soil should be left on the roots if possible so that the plants will receive only little setback from the transplanting process and grow quickly.

The plants should be placed from 10 to 12 inches apart each way. If the seed is planted directly in the field, it is sown in rows about 1 inch deep and thinned to the desired stand when the plants are well started. The seed germinates in from three to six days and grows very rapidly. Cultivation is largely done by hand because the plants are small, tender, and close together. All weeds should be kept down and the soil well tilled so that the crop will have every opportunity to make quick growth. Shading during the hot dry months promotes a better and quicker growth of lettuce.

Lettuce is edible at any stage while it is young, but it should be allowed to fully develop before it is harvested. For marketing, the plant should be cut off just above the surface of the ground after it has attained full size, but before it has developed a bitter taste or has

started to form a seed stem. The first lettuce will be ready for harvesting within 30 to 40 days after planting, and the last of the plants can be harvested three weeks later if weather conditions are good.

A comparatively large number of varieties of lettuce have been tried at the experiment station. Most of them have done well during the cool season. The Cos variety was more successful during the hot weather than at any other time, especially when the plants were not shaded. (Pl. X, fig. 1.) Some trouble was experienced in getting the heading type to head. This is sometimes accomplished by tying the outer leaves together over the inner ones. Most of the varieties of this sort form a dense rosette of leaves instead of a head. The varieties that have given the most satisfaction at the station are White Paris Cos, Iceberg, and Mignonette. White Paris Cos has long, upright leaves with heavy, straight midribs. Iceberg is medium in size, crisp, and tender. Mignonette is a sweet, crisp, curly type which is of the heading type in the States. The yields from these three varieties are greatest in the order in which they are named.

#### MINT (*Mentha* sp.).

Mint, locally known by the Spanish name of yerba buena, is grown in Guam for seasoning soups and meats and sometimes for use in medicines. This aromatic herb is planted rather thickly where it is to remain. The soil should be rich, mellow, slightly moist but well-drained, and shaded at least while the plants are young. Seeds are planted in drills about 18 inches apart. Plants from seeds are slow in getting started, and it is therefore more satisfactory to plant cuttings or sprigs of the plant. If cuttings 6 inches long are placed in the ground about 4 inches deep and spaced from 18 to 24 inches apart, they will soon cover the ground. During the dry season the plants should be watered. Cultivation consists in keeping the weeds removed from the plat.

#### MUSKMELON (*Cucumis melo*).

Imported muskmelons have been failures in a large number of tests conducted by the experiment station. The vines make a good growth and set a large number of fruits, most of which drop when they are about the size of baseballs. Only an occasional melon has matured. The so-called native melons do much better than the introduced varieties and produce a fair crop with reasonable assurance of success. Many of the melons produced at this station were of an inferior quality, being flat and insipid in taste, although they were perfectly formed and had an agreeable aroma. Others produced were of excellent flavor and texture. The results of all the



tests seem to indicate that, if selection of the best varieties were practiced, the muskmelon would be a very good crop for Guam.

Muskmelons do well on heavy clay loams that are well-drained and fairly fertile. The cultural requirements are the same as for cucumbers. The melons should be left on the vine until they ripen. When picked before maturing, they lack the delicious flavor that the mature melon possesses. Some melons drop from the vine when they are ready for harvesting; others are ready for harvesting only after they have turned yellow. The best time to harvest the different varieties can be ascertained only by experience with them. However, the appearance and the pleasant aroma of the ripe melons are the best means of judging their ripeness. In Guam from 10 to 11 weeks are required for the vine to ripen fruit after planting. The average period of production of ripe fruit from all plantings was found to be 21 days at the station.

Of 30 or more imported varieties which were tested here, the variety known as Burrell's Gem has given the most satisfaction. Very gratifying results were recently obtained from some of the local varieties, which were developed through selection of some of the best varieties.

#### MUSTARD (*Brassica juncea*).

Mustard grows well in Guam, especially when it is planted before and during the rainy season. The leaves are largely used as "greens" or boiled with meat. Mustard grows well in a loam soil, and produces a better quality of leaves than it does when it is grown in a very sandy or a very heavy clay soil. Good drainage is essential for best growths. The seeds should be sown in drills an inch deep and about 18 inches apart. After the plants are 2 or 3 inches high they should be thinned to 4 or 5 inches apart. Ordinary cultivation is all that the plants require. The first leaves are ready for harvesting in from 45 to 60 days, depending upon the favorableness of soil and weather conditions for plant growth. The average time in 14 tests at the experiment station from planting to first harvest was 54 days. Plants were harvested from then until 18 days afterwards.

#### OKRA (*Hibiscus esculentus*).

Okra makes an unusually vigorous growth and is correspondingly productive in Guam. The plant may produce several crops if it is cultivated and given proper care. It is very resistant to drought, and often furnishes a green vegetable when other garden vegetables can not be obtained.

Okra thrives on most soils that are well drained, but makes its best growth on loam or clay loam soils. The plant is hardy and

productive, and responds to cultivation by greatly increased yields. The soil should be prepared rather deeply, because the plant is a deep feeder. The seeds are large, and nearly all germinate without difficulty. The seed should be sown 2 inches deep at the rate of 3 or 4 to a hill. The hills should be made 3 feet apart each way, or the seed may be planted in rows 6 feet apart, one plant being placed every 18 inches apart. Cultivation can readily be done with any suitable animal-drawn implement, because the plants are upright in growth, large, and planted far apart. Only a few okra plants need be planted in the home garden, as they will supply all the pods that the family will want.

The green pods, which are the edible part of the plant, are harvested when they are young and tender, as they are worthless when they become tough or hard. The pods are in right condition for harvesting and are edible when they can be snapped off without tearing or bending. Green pods are ready to be harvested within 9 or 10 weeks after date of planting. The plants continue to bear pods for several months, provided that they are given good cultivation and care. The experiment station found it good practice to prune the plants back when they attained a height of 7 or 8 feet, at which stage harvesting became difficult. Plants were cut off at heights of 3 feet from the ground to as low as  $1\frac{1}{2}$  feet, after which they became bushier and more productive. All pods should be picked while they are young and tender. The plant dies when the pods are allowed to ripen on it. When more pods are produced than can be used immediately they should be sliced and dried, so that they can be kept in good condition for future use. The tender pods should be picked every day, or at least three times a week, whether or not they are needed, so that the plant will continue to produce.

The two varieties of okra which have been grown in Guam are the Perkins Mammoth and the White Velvet. The former variety bears long, slender, deep-green pods, and the latter produces medium-size, smooth, white pods. Both varieties are well adapted to local conditions.

#### ONIONS (*Allium cepa*).

Onions from seed are grown with great difficulty in this humid climate owing to the poor germination of the seed. Low viability has occurred in a large number of shipments of fresh seed which came direct from California. Unless the seed is planted immediately it becomes worthless, some of it losing its germinating power in less than a month after arrival. Onions from imported sets have been more successful than from seed, but unfortunately they are more expensive. Many farmers successfully grow a small native onion (an East Indian variety of shallot), which probably was introduced



long ago into the island from Manila. This variety does very well and is a fairly good yielder.

Onions require a well-prepared, heavily manured seed bed. The soil should be moist but well-drained. A rich loam should be selected if it can be had, although a sandy loam is also suitable, provided it can be watered frequently in the dry season. A steady even growth is required for the production of good onions.

Fresh seeds should always be used for planting either in the field or in seed boxes. When planted in the field the seeds are sown in drills 1 inch deep and 18 inches apart. Since the seeds are rather slow to germinate, it might be well to plant at the same time a few radish seeds, which will come up in a very short time and mark the rows until the onions are large enough to be seen. If the seeds are planted in seed boxes the young seedlings can be transplanted when they are about 6 weeks old, or while they are still smaller than a lead pencil. These seedlings should be set about 4 or 5 inches apart in the row.

The native onions are planted from root divisions. The tops are cut off 2 or 3 inches above the roots and are planted much the same as are sets or the seedlings. Some difficulty has been experienced in Guam in ripening onions even after they have fully developed. The whole crop can be hastened to maturity by bending over the tops with a roller (Pl. X, fig. 2). The onions can be removed from the ground in about 10 days after this has been done, and if they are dried for a few days they will keep for an indefinite period. Green onions can be pulled in from 40 to 60 days after the seed has been planted. Onions from sets require 100 to 150 days to fully mature. Native onions require 80 to 125 days to mature after the root divisions are planted.

#### PAPAYA (*Carica papaya*).

The papaya is grown extensively in Guam for the fruit that it produces (Pl. XI, fig. 1). It is sometimes called the melon-tree and is often incorrectly spoken of as the pawpaw, which is an entirely different plant. The young green fruits are cooked as a vegetable, much in the same manner as summer squash is prepared and are considered by many to be superior to the latter. The papaya fruits all the year round and many of the trees form more fruits than can properly develop or mature. These fruits should be thinned and the young fruit that is moved should be used as a vegetable.

The papaya should be planted in well-drained soil, else the roots will rot and the trees fall over. It is also well to provide the plant with suitable windbreaks, as it is easily uprooted during heavy winds.

Plants are started from seed. Cuttings will take root, and the plant can be grafted or budded, but these processes are so much slower than growing from seed that they are seldom used except to

perpetuate a particular strain or variety when there is danger of cross-fertilization. The seeds are started in seed boxes, being planted rather thinly. After the plants are 4 inches high they should be transplanted to bamboo pots. From there they may be transplanted to the field during favorable weather any time after they are 8 to 12 inches high. The ground should be well prepared for transplanting and holes should be spaced about 10 feet each way. Chicken or barnyard manure furnishes an excellent fertilizer for papayas and greatly increases the yield and quality of the fruit. Legumes which are planted between the rows for cover crops keep down weeds and lessen the labor of cultivation.

The papaya yields fruit in from 8 to 12 months after planting and continues to produce for 2 to 4 years afterwards. A few trees of the Hawaiian variety will supply all the fruit that a family needs, both for a green vegetable and for ripe fruits.

PARSLEY (*Carum petroselinum*).

Parsley grows well in Guam, and a small amount of it should be found in every garden. The roots of the large varieties are edible as well as the dark-green leaves, which are used to garnish dishes of meat.

Seed of parsley should be sown when conditions are favorable and where the plant is to remain. It may be planted at any time of the year, but it must be watered during the dry season and the soil well drained during the rainy season. The seed should be sown thickly in rows 12 to 18 inches apart and about 1 inch deep. The leaves should be harvested frequently and the plant kept producing new growth to prevent it from seeding. A few plants can be kept growing in a box around the house so that a supply can be had for garnishing when it is wanted. The leaves can be harvested within 3 to 5 months after planting and from then on for several months if the plants are properly cared for. The market would be overstocked were parsley grown in any quantity, but at present there is not enough of it grown to supply the demand. Parsley is grown largely for home use and a few hills will supply that demand.

PATOLA (*Luffa ægyptiaca*).

The edible dishcloth gourd, or, as it is known in the Philippines, the sponge gourd, so called from its fibrous interior which is often prepared for use as a sponge, has been grown in Guam with very satisfactory results (Pl. XI, fig. 2). Seeds of the patola are planted in hills, and require the same soil conditions and cultivation as cucumbers. The vines will climb if they are planted along fences or trel-



lises. When the seeds are planted near these, the hills should be spaced 10 feet apart. Yields are greatly increased by mixing manure in the hills before the seeds are planted.

PEAS (*Pisum sativum*).

The ordinary garden pea does not grow well in Guam. In plantings made at this station only those peas which matured in or around March produced anything like a successful crop. These plants produced during the coolest growing period of the year, which probably accounts for the partial success of plantings at that time.

Pea seeds are dropped about 2 inches apart in rows 2 inches deep and ordinarily 18 to 24 inches apart. Supports for the vines are provided by placing brush upright in the row. Two rows may be planted 8 inches apart, with a 3-foot space between the double rows. In plantings of this kind no brush is provided because the vines support each other. However, the first method generally gives a larger yield, although it requires more labor to provide the supports. Unless they are planted at a high elevation it is useless to plant peas the year around. Plantings made from November to February may be successful if weather conditions are favorable. Peas are produced in from 40 to 60 days.

PECHAY (*Brassica chinensis*).

This plant is grown for its large, tender leaves, which are used as greens (Pl. XII, fig. 1). It is closely related to the cabbage, but is better adapted to the Tropics than is the latter. Few of the common varieties ever form heads.

Pechay is planted in seed boxes, and when large enough is transplanted to the garden in rows 18 inches apart. The plants are spaced 6 inches apart. The soil should contain a large amount of organic matter because the plants must be forced to make a quick growth so that the leaves will be large and tender. The thick, strong petioles may also be cooked with the leaves or all may be used as salad. It is a good dry-weather plant, being ready for use within a few weeks after planting.

PEPINO (*Cucurbita* sp.).

The pepino has many characteristics common to both the cucumber and the muskmelon. It is commonly known by the Spanish name of *pepino*, meaning cucumber. Its exact origin is unknown. Some think it is a hybrid of the native melon, some report it as endemic to Guam, while others think it was imported years ago into Guam. The plant is prolific and bears a fruit that is very agreeable to the taste. It is used as salad or in much the same manner as a muskmelon.

The pepino requires the same cultivation as the cucumber. In 10 tests, conducted by the experiment station, the pepino matured fruit on an average of 77 days, and the vines continued to bear for 29 days afterwards. There are different kinds of pepino, but the best is that known as the white pepino, so called from its pale green, or almost white, appearance when ripe.

#### PEPPERS (*Capsicum* spp.).

The Chamorro people are very fond of the pepper, which thrives in Guam in numerous forms from the small, hot, pungent to the very large, mild varieties (Pl. XII, fig. 2). The small varieties are often found growing wild where they have escaped from cultivation. All varieties are very easily produced, but good quality depends largely upon soil and climatic conditions, which can be controlled to a certain extent by drainage, irrigation, and partial shade.

Peppers will grow successfully on nearly all the ordinary soils in Guam, from the light sandy types to heavy clays, but a light loam is preferable. If manure is added to the soil, the peppers and the yields of peppers will be larger and their quality will be better than would be the case were they grown on untreated soil.

The seed of the pepper should be planted in finely prepared soil in seed boxes. If the soil is leveled and then gently firmed down in the seed box, the seed can be thinly scattered over the soil or planted in shallow rows. Fine soil should then be placed on top of the seed to a depth of one-quarter of an inch and watered. The young plants will appear in a few days. When they are 6 inches high they should be transplanted, first being thoroughly watered and then removed from the boxes with as much soil as possible. The bamboo pot can be split and the soil and plant set out together without disturbing the roots. The imported varieties are placed about 18 inches apart each way, while the hot, native varieties are placed about 3 feet apart. The experiment station has found it profitable to provide partial shade for peppers, especially during the dry season. When shade was provided the yields were larger and the quality of fruit was better, the peppers being larger, sweeter, and crisper than were those grown without shade. Where no shade was provided the successful transplanting of peppers was found very difficult in the dry season.

Cultivation required for peppers depends largely upon soil conditions. A loose soil of a sandy nature needs frequent cultivation to conserve the moisture and a heavy soil needs loosening to admit the air to the soil. Thorough cultivation should be given in any case, but after the plant has fully developed care should be taken not to injure the root system by too deep cultivation. In all cases, especially during the rainy season, good drainage should be provided.





FIG. 2.—PATOLAS.



FIG. 1.—PAPAYA.





FIG. 1.—PECHAY OR CHINESE CABBAGE.

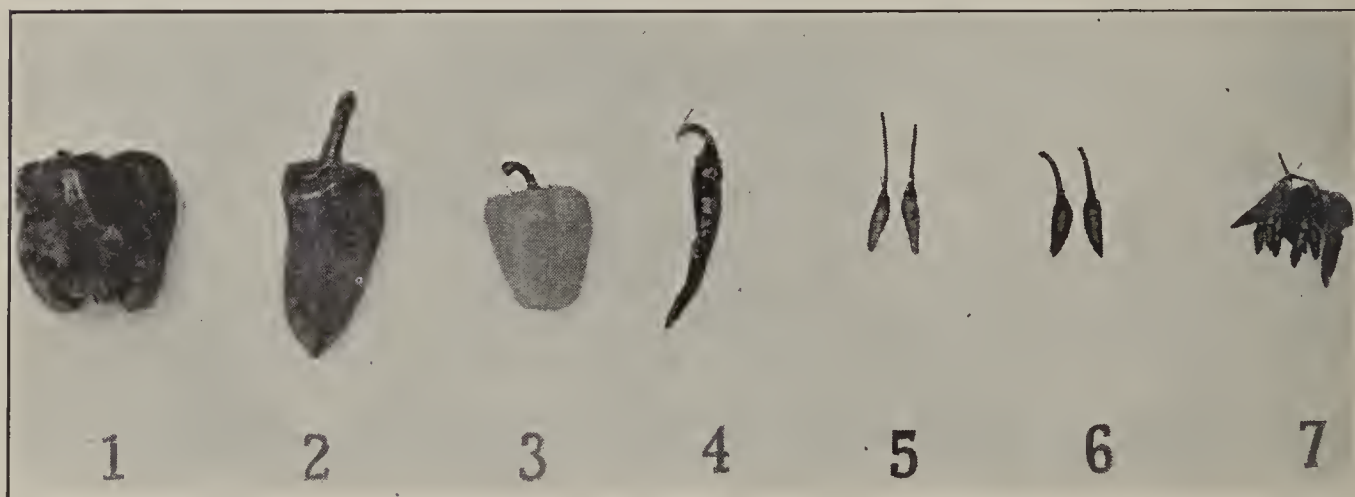


FIG. 2.—TYPES OF PEPPERS. 1, BULL NOSE; 2, SWEET PIMENTO; 3, GOLDEN DAWN; 4, CAYENNE; 5, DONI ESPAÑA; 6, DONI SALE; 7, DONI SAIPAN (DIQUIQUI).



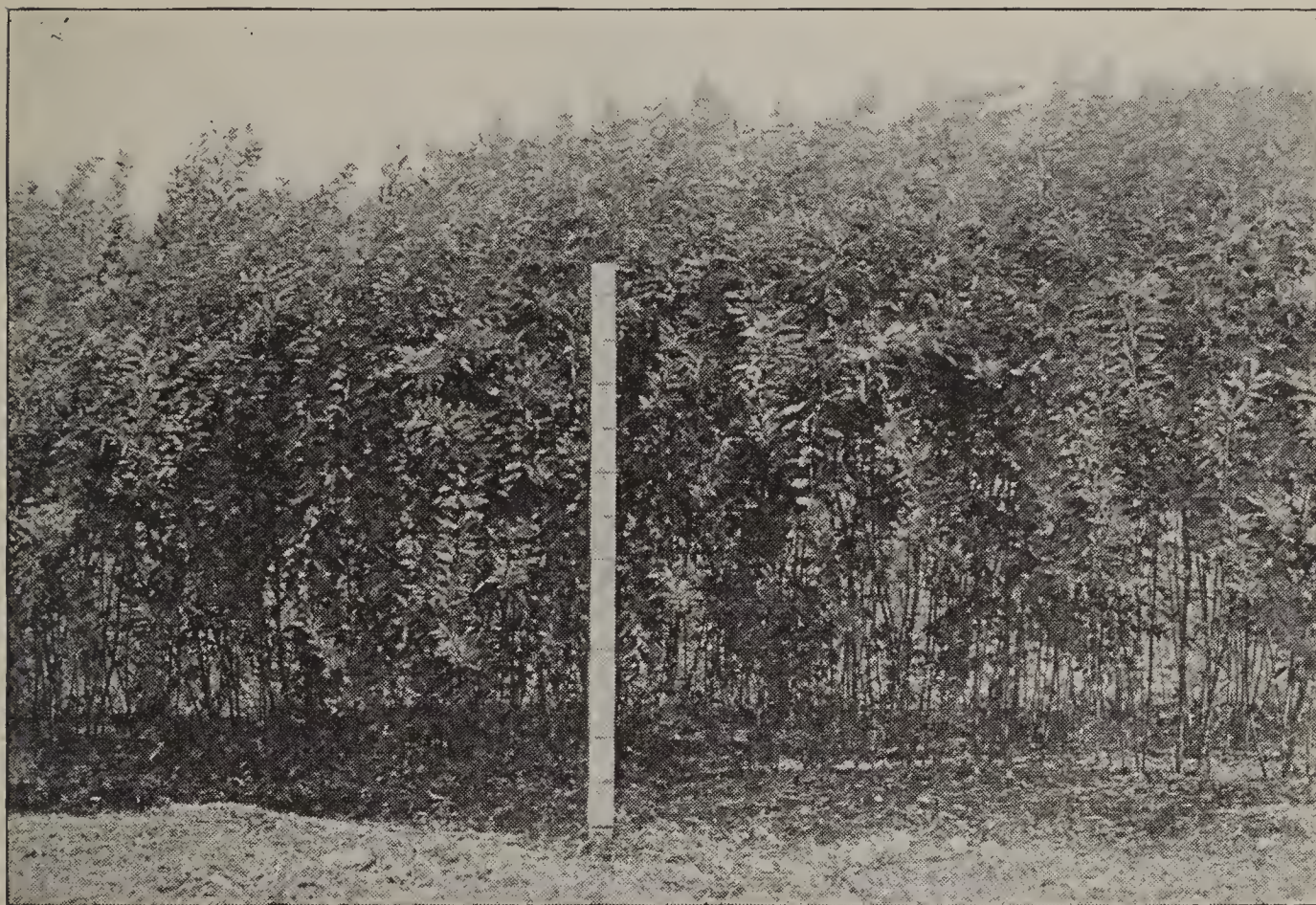


FIG. 1.—PIGEON PEAS GROWN AS A WINDBREAK.



FIG. 2.—PUMPKINS.





FIG. 1.—RADISHES. LEFT, CINCINNATI MARKET; RIGHT, CHINESE WHITE WINTER.



FIG. 2.—CHINESE WHITE RADISH.



because pepper plants soon die if the soil becomes water soaked, although they will grow well on subsoil that retains moisture. Land planted to peppers, especially unfavorable locations, should be irrigated during the dry season if production is to be kept up to the maximum.

The pods on most varieties turn red when ripe. The sweet varieties are usually eaten while they are still green but after they have fully developed. Home-grown selected seed will produce vigorous and prolific plants for at least several generations. Seed from desirable plants only should be saved for planting. These specimens should be healthy, vigorous, and prolific, and produce a type of pepper that is adapted to the purpose for which it is wanted. The pods, after being allowed to ripen, should be picked and sun dried and the seed removed. After the seed has been dried thoroughly it should be placed in a tightly stoppered bottle or an air-tight seed container. If properly dried and cared for, the seed will keep for some time without losing its germinating power.

Many varieties of peppers grow in Guam. They are divided into two classes, the hot and the sweet varieties. The hot varieties are the Cayenne, Red Chili, Red Cherry, and the red and yellow varieties of the native peppers growing in Guam. After ripening they are used for seasoning, being made into curry powder, tabasco sauce, and Cayenne pepper. All these varieties can be preserved by drying in the sun. The sweet varieties are the Chinese Giant, Large Bell or Bull-Nose, Sweet Pimiento, and Golden Dawn.

#### PIGEON PEA (*Cajanus indicus*).

The pigeon pea is a tall, woody shrub bearing edible peas, which are used in the unripe stage as a substitute for the common garden peas. The ripe peas are eaten to some extent, but they are generally attacked by weevils, which frequently cause the loss of the entire crop. The pigeon pea can be grown in the garden as a vegetable, but it makes such an excellent windbreak that it should be planted in two or three rows around the outside of the garden, where it can serve the double purpose of producing edible peas and providing shelter (Pl. XIII, fig. 1.) The tender, unripe peas, when shelled and properly cooked, compare very favorably with the garden pea.

The pigeon pea must be grown on well-drained soil because its roots are attacked by a fungus disease known as root rot if the plant is grown in wet soil. It will grow on nearly any type of soil and needs very little cultivation after it is once well started. This plant begins to bear in from six to eight months after planting and continues to produce from several months to several years, depending upon soil conditions and the cultural methods practiced. The largest

yield is secured during the dry season. During the wet season of the second year the plants can be pruned to within 3 feet of the ground, after which they will give a higher yield. It is seldom that the plant does well after the third year, at which time it is advisable to replant.

The ripe seeds are attacked and severely damaged by small larvæ which work within the pods. In order to save the seed, the ripe pods should be picked and shelled promptly, and the seed should be dried, fumigated, and stored in tight containers.

#### PLANTAIN (*Musa paradisiaca*).

The plantain, a distinctive variety of banana, is an important tropical plant which produces fruit at all times of the year. Its fruit is much larger than the common edible banana. Some varieties produce only a few fruits, which are long and loosely set in the bunch. The fruit of the plantain is firmer in texture than the edible banana, but hardly as sweet. It is not suitable for eating raw. Generally, it is used as a vegetable before it is entirely ripe, being roasted, baked, or boiled, and substituted for bread or potatoes; after ripening it is often fried in lard or coconut oil. Cultural directions and soil requirements are similar to those required for the banana.

#### POTATOES (*Solanum tuberosum*).

Repeated attempts have been made to grow potatoes in Guam but without success. Small potatoes can be produced here during the cool season on the highest elevations, but the yields are scarcely more than the amount of seed planted.

#### PUMPKIN (*Cucurbita* sp.).

Pumpkins have been grown very successfully at the experiment station (Pl. XIII, fig. 2), but, like other cucurbits, they give little, if any, yield if repeatedly planted on the same ground. This failure is probably caused by a very virulent form of powdery mildew, which attacks the foliage and becomes more prevalent with each succeeding planting on the same ground.

Pumpkins will grow well on almost any well-drained soil. Three or four seeds are planted in hills 6 feet apart each way. Otherwise, they should be planted, fertilized, and cultivated in a manner similar to that required for cucumbers. Pumpkins will keep for some time after being harvested provided that they are placed in a dry, shady place.

#### RADISH (*Raphanus sativus*).

Excellent radishes can be grown in Guam without difficulty so far as climatic conditions are concerned. The radish root is eaten raw with a little salt or it may be cooked like turnips. The leaves are



used as greens, being cooked in the same way as spinach. The radish is perhaps the most easily and quickly grown of any vegetable in Guam. The best radishes are crisp, tender, and free from pith or any pungency in taste.

Radishes are not exacting as to soil conditions, but to be of good quality they must be grown quickly. For this reason the soil should be fairly loose, fertile, and well-drained. Fresh viable seeds are planted in rows 1 inch deep and 12 to 18 inches apart in well-prepared seed beds. If the seeds are carefully planted about 1 inch apart, there will be no need to thin the plants. Cultivation consists in keeping the weeds down and the soil loose. In case the plants do not make rapid growth they should be fertilized with some liquid manure.

The roots can be eaten as soon as they are large enough. The first roots should be ready to pull in three or four weeks' time and the whole harvest should be completed in two months' time. The large Chinese variety requires about 10 days longer to mature. Quality must not be sacrificed to secure large roots. After the radish is ready for harvesting it will remain tender and crisp for only 5 to 7 days. After this it develops a hot, pungent flavor and becomes pithy. The White Chinese variety is an exception because its large roots develop more uniformly and remain crisp and tender for a long period.

A number of varieties have been grown at the experiment station, but the Early Globe Scarlet, Cincinnati Market (Pl. XIV, fig. 1), and the White Chinese (Pl. XIV, fig. 1) have been the most successful. The last variety is quite distinct from the Chinese White Winter (Pl. XIV, fig. 2), which is advertised by some seed companies. The seed was grown from Chinese-produced seed, which had been introduced from Manila by this station. The Early Globe Scarlet is a small, slightly oblong, red, tipped with white, radish that matures very quickly. The Cincinnati Market is a half long, slender, red variety that matures a few days later than the Early Globe Scarlet.

May is one of the best months to plant radish to secure large yields. Plantings made in September, March, and August also yield well. The lowest yields are secured from plantings which are made in January, February, June, and November.

#### ROSELLE (*Hibiscus sabdariffa*).

Roselle is another tropical plant that is well adapted to Guam conditions. The bright red calyx of the fruit, or rather of the flower, is the part used in making jelly, sauce, or a refreshing beverage. The leaves are used for jelly making or for cooking as greens. The jelly made from roselle will easily take the place of currant or cranberry jellies, neither of which plants grow in the Tropics. In Guam the roselle plant fruits twice a year. If planted after the first of No-

vember and before the last of January it will first fruit in March and then again in October or November. After this the plant usually dies, although it sometimes produces another crop. If roselle is pruned back after the first crop, the second crop will be larger owing to the increased number of fruiting branches.

Roselle may be propagated by seed or by cuttings, but since it grows quickly and easily the former method is generally followed. The seeds are planted in hills about 3 feet apart each way. As long as it is possible to do so without injuring the plant roselle is cultivated in a manner similarly to that given corn. Plants are thinned to one healthy plant in a hill as soon as they are 6 to 8 inches high.

The roselle flowers in April and October, or thereabouts, according to the weather conditions, regardless of the time of planting or the size of the plants. The calyxes are harvested while they are still tender and before the pods become woody or fibrous. The stem just below the calyxes, or pods, breaks easily when the pods are still crisp, tender, and full. Yields of pods have varied, but on fairly good soils over 4 pounds to the plant have been secured from one picking. In making sauce the green seed pod is removed from within the calyx. This operation is easily done by cutting or running a sharp knife around the lower end of the calyx, from which the seed pod drops out.

#### SPINACH (*Spinacia oleracea*):

Spinach (Spanish, *espinaca*) can be grown in Guam only during favorable seasons and with suitable soil conditions. The leaves are cooked as greens. This vegetable has become known in Guam through the importation of canned spinach. There are growing on the island a large number of vegetables which can readily be substituted for spinach. It is suggested that these be planted, except on the smaller areas where spinach might be successful, during the cooler season of the year. Acelga, collards, young taro leaves, roselle leaves, and the like, when properly cooked and seasoned, taste very much like spinach.

Spinach must be kept growing rapidly to produce a good quality of leaves. A moist, rich loam soil, which is not soggy, is required for this purpose. It should be well prepared before the vegetable is planted, and conditions should be made as favorable as possible for quick growth. Plantings are made from November to February, which is the cooler season of the year. The seed should be planted rather thickly in rows 1 inch deep and 16 inches apart. The plants should be thinned to 6 to 8 inches apart in the row. The soil should be frequently cultivated to promote early growth of the plant, and when there is continuous hot sunshine the plants should be provided with partial shade and the soil should be kept moist by irrigation.



The outer leaves are picked as they mature and frequent harvests are therefore necessary to secure the best quality of leaves. The first leaves should be ready for harvesting in from 6 to 9 weeks after the seeds are planted. New Zealand spinach is better adapted to Guam than are the more common varieties which grow in the States.

\* SQUASH (*Cucurbita* sp.).

The squash, locally known as *calamasa*, is grown in Guam with a fair degree of success. A soil that will produce good cucumbers will also grow good squash. A fairly fertile soil, which contains some sand, is well adapted to this plant provided that the garden is well drained. The soil for squash should be well prepared and fertilized in the hill, or better still, top-dressings can be made of the fertilizer and mixed with the upper surface soil. The plant is a shallow feeder and consequently requires a loose surface so that the roots can find sufficient food.

Squash is planted in hills. The bush variety is planted by placing 3 or 4 seeds 2 inches deep in hills 3 or 4 feet apart each way. The vine varieties are planted in hills about 6 feet apart each way. Clean shallow cultivation is all that is required to keep the plants growing. As they are rapid growers the vines are very tender and therefore easily damaged by heavy winds. Soil is sometimes piled up around the hills so as to keep the plants from whipping in the wind.

The bush summer variety should be harvested before the outside becomes hard or shell-like because the quality is much better when the fruits are still tender. The vine type of squash is a much better keeper than the small bush type and does not need to be harvested as promptly. The average time required for the production of summer squash in 30 tests conducted by the experiment station was 62 days. The plants bore fruit for an average of 63 days after production started. The summer variety known as Mammoth White Bush Scallop has been found to be well adapted to Guam conditions. (Pl. XV, fig. 1.)

In addition to the imported squash there are a number of native varieties which grow on the island. None of them is considered a high yielder, yet some have a very good flavor and could probably be greatly improved were they properly selected through a few generations.

SWEET POTATOES (*Ipomœa batatas*).

Sweet potatoes will grow at practically any time of the year, but do best when they are planted after the middle of the rainy season. They are grown extensively in certain places, especially after the island has been visited by destructive typhoons, which damage other growing crops and make urgent the need of quick-maturing food plants.

Sweet potatoes are commonly planted on the high land (the mesas), where the soil is too exhausted to produce other crops. They will, however, give larger returns when they are grown on good soil, preferably a fertile sandy loam. The soil should be plowed very deep, and when planting is done during the rainy season the rows should be set on ridges thrown up by means of a plow, two furrows being turned together. On the heavier soils at the experiment station very good results were obtained from plantings following the turning under of green manure.

Plants are frequently started from cuttings, which are made by removing pieces of the vines 12 to 18 inches long. Either the basal end or middle of the cutting should be placed or buried about 4 inches in the soil, and the cuttings should always be taken from healthy and vigorous vines. The original plants which furnish the vines to make cuttings are obtained by bedding the sweet potatoes and drawing the slips. This method requires a longer time and entails more labor than when cuttings are used. The potatoes are bedded close together in a well-prepared seed bed which is well drained. Shelter should be provided to prevent heavy rains causing an excess of moisture in the soil. After the soil is mixed with manure and made perfectly fine, the potatoes should be covered with it to a depth of 1 inch. The seed bed should be watered as often as necessary to keep the soil in good condition. The smaller potatoes are usually bedded for slips, which are ready to draw in from 5 to 7 weeks. The bed should be thoroughly watered and the plants carefully pulled out, one hand being kept on the surface of the soil to prevent the sweet potato from being pulled out of the seed bed. A second crop of slips will be ready to draw in about 3 or 4 weeks later.

Sweet potatoes are planted in rows from 3 to 4 feet apart, either cuttings or slips being placed 12 to 18 inches apart in the row. Cultivation consists in keeping the ground free from weeds and the soil in good tilth until the vines have covered the ground. Sweet potatoes are harvested in from three to six months after being set out in the field, according to the variety grown. Of the varieties commonly grown on the island the Yap is the earliest of all and the Amarillo is considered next, both maturing in about three months. (Pl. XV, fig. 2.)

In Guam it is customary to begin digging sweet potatoes for home use as soon as they are large enough to eat. They will keep in the ground for a reasonable time, but it is advisable to harvest them as soon as they fully develop. If this is not done they are greatly damaged by the sweet potato weevils (*Cylas formicarius* and *Euscepes batatae*), which tunnel through the root. If the potatoes are har-



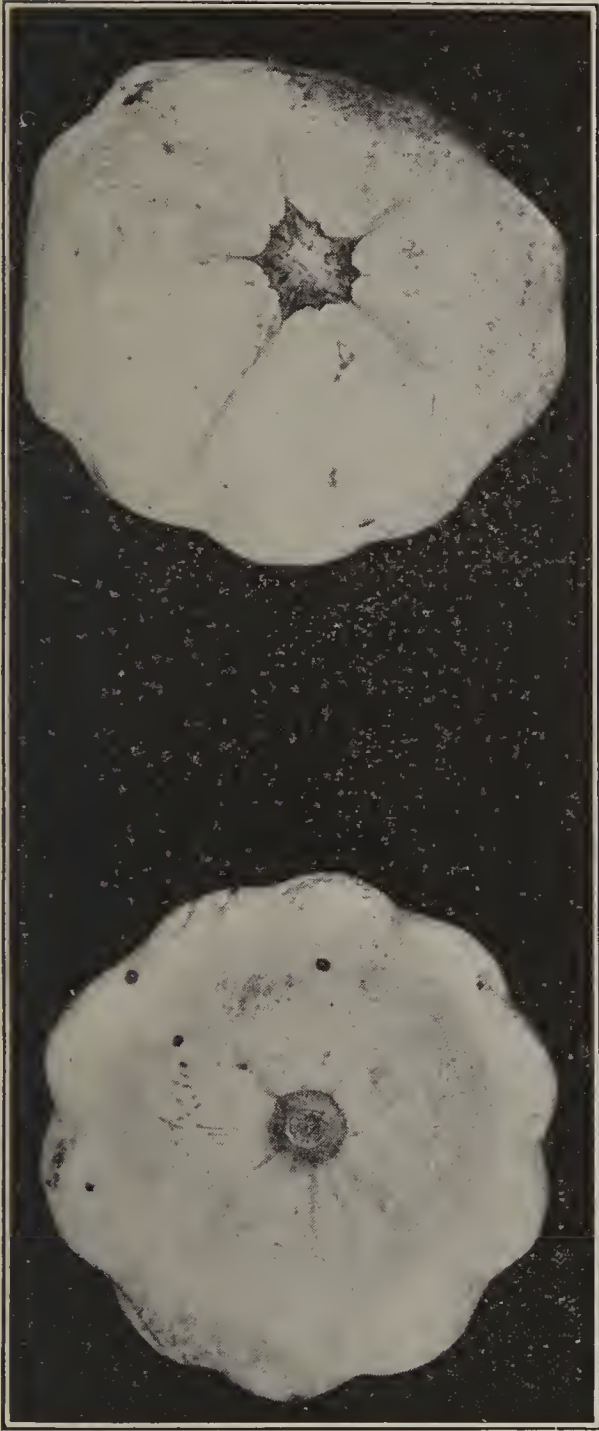


FIG. 1.—BUSH SUMMER SQUASH.

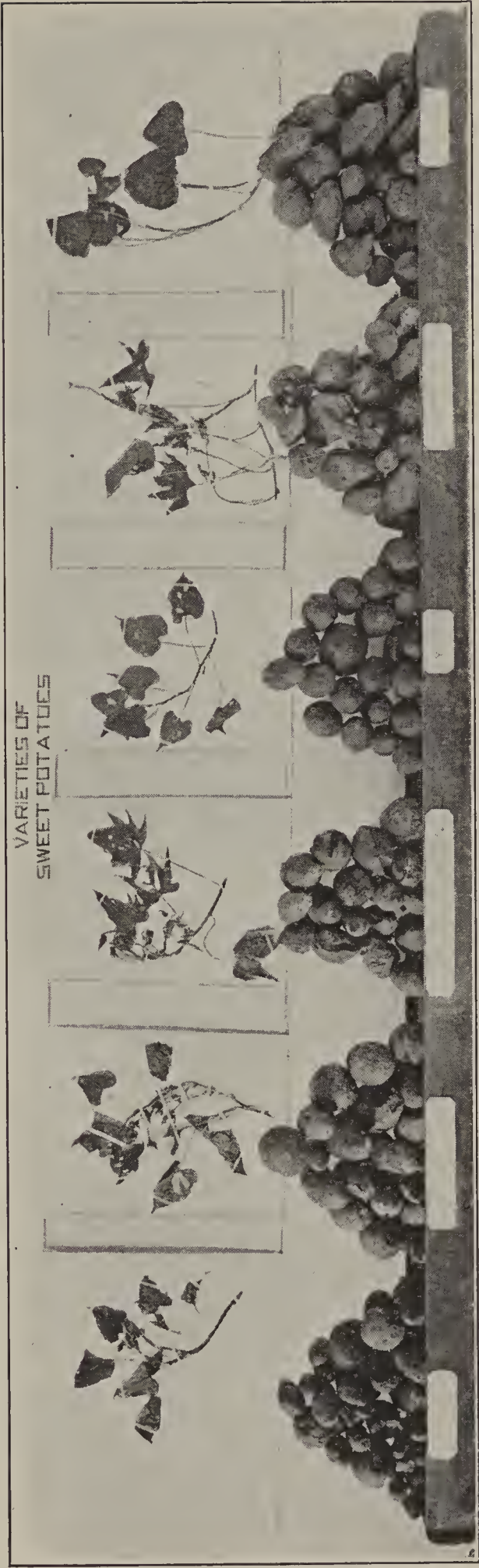
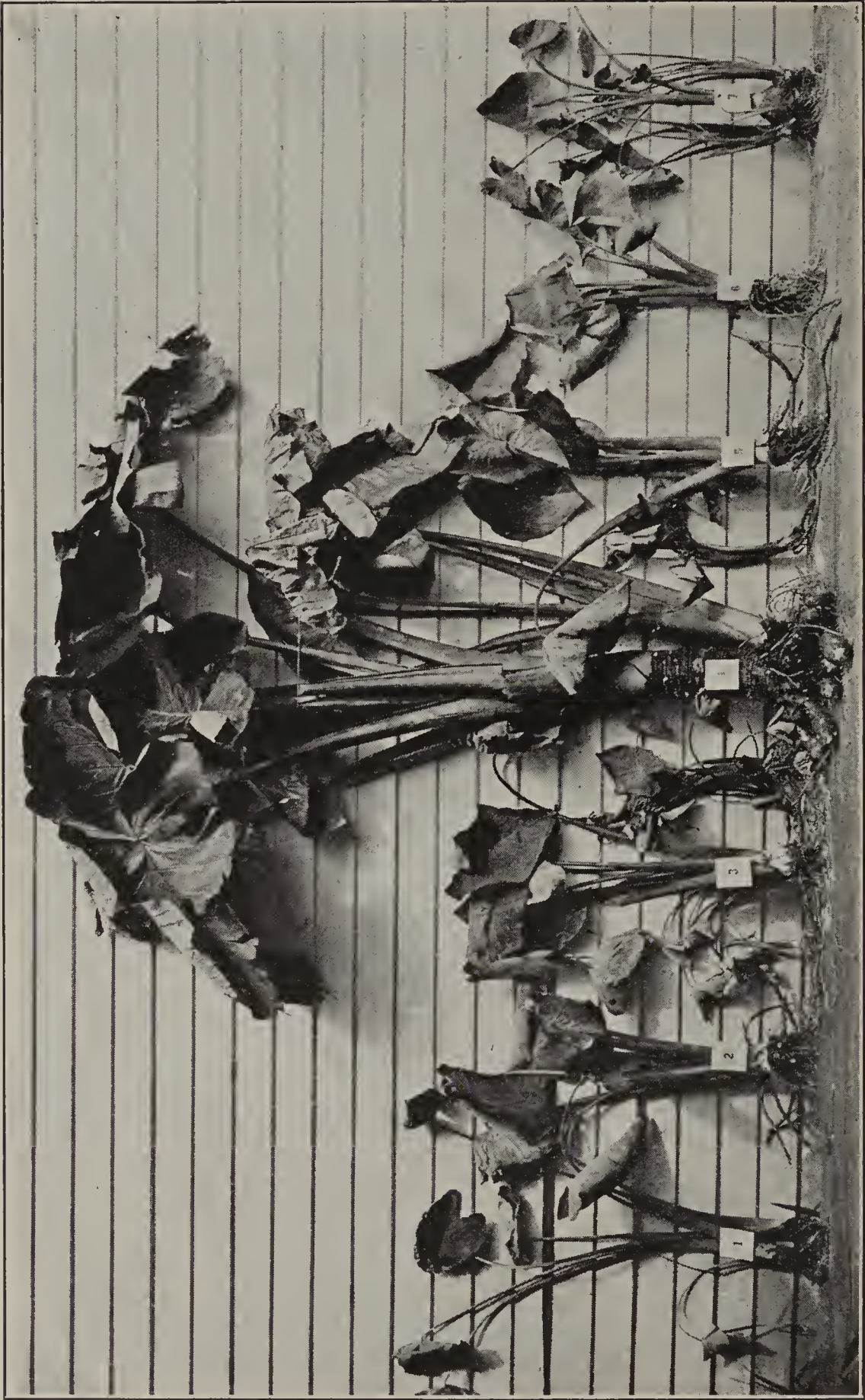


FIG. 2.—VARIETIES OF SWEET POTATOES. LEFT TO RIGHT, DAGO, AMARILLO, PATAS ÑGAÑGA, YAP, IMPORTED, AND PERU.





TARO VARIETIES. 1, APACA; 2, MANILA; 3, VISCAYA; 4, AMERICAN; 5, HALOM-TANO; 6, PACEANCIA; AND 7, AGRIGAN.



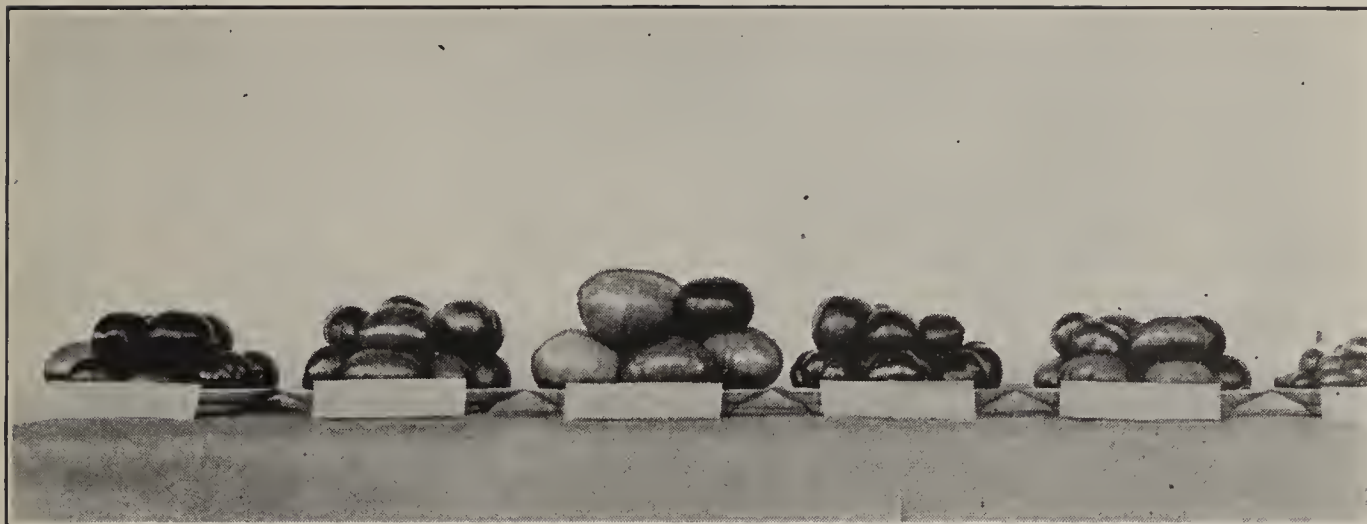


FIG. 1.—TOMATO VARIETIES. LEFT TO RIGHT, STONE, DWARF CHAMPION, PONDEROSA, HAWAII HYBRID, CRISTOBAL, AND UBA (NATIVE).



FIG. 2.—WATERMELONS.





vested before these insects do any great damage, the roots can be sliced and dried and kept for several months provided that they are stored in air-tight containers. The best precaution to take against invasion by weevils is to plant only on ground which has not been formerly planted to sweet potatoes.

TARO (*Colocasia esculenta*).

Taro, or suni, as it is called locally, grows well in Guam and is extensively used as a food. (Pl. XVI.) It, or some similar plant, is known in other tropical countries as cocoes, tayas, yautias, tancias, tanners, eddoes, and dasheens. The large bulbous roots are used in many ways similar to the way the white or Irish potato is used, and the young stems and leaves are cooked like asparagus and spinach. Taro is usually considered a lowland plant, but it is also planted on the upland, especially on newly cleared areas, although in such situations it makes very little growth during the dry season. Some varieties, however, are more suited to these locations than are others.

Taro is not particular as to soil conditions, but best results are obtained from plantings made on low, moist soil on which water does not stand. During the rainy season taro is commonly planted with bananas on land that has recently been cleared but which is still too full of stumps for cultivation. Whenever it is possible to do so, the land should be plowed. Small suckers, tubers, and the tops of rootstocks are used in planting taro. Propagation material should be taken only from healthy, vigorous plants to secure like plants. All broken roots should be trimmed off the tubers before they are planted. The tops of the rootstocks are cut off about an inch below the crown and the leaf stems are cut off 3 or 4 inches above the crown. Plants should be set from 2 to 4 feet apart, according to the variety being planted. The small kinds are set closer together than are the larger varieties. Holes are easily and quickly made with a sharp-pointed stick that is about 2 inches in diameter. Only one plant and a very small amount of soil should be placed in a hole, which should be allowed to fill up with soil and organic matter during cultivation. Little cultivation, other than keeping down the weeds, is required after the plants become well established.

The average taro matures in from 10 to 14 months. After the first 3 or 4 months some of the young leaves may be picked without injury to the plant. As the larger taro roots mature or become fully developed they may be harvested and the small suckers left to produce other plants. In this way a field of taro will last for several years if the location is a favorable one. and continue to furnish an abundance of fresh material the year round.

TOMATO (*Lycopersicum esculentum*).

Tomatoes are grown with great difficulty under the peculiar climatic conditions existing in Guam. (Pl. XVII, fig. 1.) Two small inferior varieties, one oval and the other globular in shape, both greatly variable in type having a sharp, acrid flavor, have escaped from cultivation and are growing wild on the island. Many attempts have been made to improve these native tomatoes, but none has been successful up to the present time.

In selecting a field in which to grow tomatoes, the main consideration should be to secure soil that is moist but well-drained, because the plants will not thrive in excessive moisture. A sandy loam or a clay loam is desirable but not absolutely necessary. New soil or land that has not been cropped to tomatoes for any length of time makes a good location, since the danger from insects and diseases is lessened. The soil should be well prepared before planting.

Seeds are planted rather thinly in seed boxes and covered with a shallow layer of soil. The seed box should be protected from heavy beating rains and the young plants from the hot sun. If the plants are crowded, they should be thinned. The young seedlings should be transplanted to clay pots, bamboo pots, or to other boxes to make the plants vigorous. The plant is ready to be transplanted to the garden when it is 4 to 6 inches high. A plant that is grown with a little sunlight is often spindling. The best plants are those that are stocky and have a well-developed root system. Plants which are over 6 inches high are often transplanted, but their growth is retarded and the plant is never as vigorous and fruitful as one that is planted at the proper time. This point can not be too strongly emphasized, because many people leave the plants in the pots until they become root bound from lack of proper space in which to develop a good root system. If there is no likelihood of heavy rains and the soil has been properly prepared, the seed may be planted in hills where the plants are to remain permanently.

Tomato plants are set 3 feet apart each way. If it is hot weather, the plants should be shaded for a few days to allow them to become well established. During the hot, dry season, shade, such as is described for peppers, is often beneficial. In seasons when frequent rains are likely to occur, the experiment station has found it of advantage to use a bamboo frame for the vine to climb upon. This frame, which is raised 1 foot from the ground and has several cross-pieces, prevents the vines from spreading along the ground and lessens the tendency of their becoming affected by disease. When the plants are laden with fruit they can be tied loosely to stakes set at each plant to prevent them from lying on the ground. In case the tomato



plants go too much to vines and set few fruits the end of the vines should be pinched off, preventing further growth and causing the fruit to set.

Clean and frequent cultivation to keep down the weeds and loosen the soil is required to keep the plants in a growing and thrifty condition. Much of this work can be accomplished with a hand cultivator. Care should be taken not to injure the roots after the plants have begun to blossom because the bloom is likely to fall. The plants must be supplied with water during the dry season whenever the soil shows any lack of moisture; otherwise they will suffer and be difficult to keep in a fruiting condition.

In Guam, unless tomatoes are picked before they turn red and ripen, they will crack open. This cracking can be prevented by picking the fruit when it turns a light green or whitish color, or shows a slight tinge of red. At this stage the fruit should be sent to the Agaña market. If carefully packed and handled, tomatoes can be brought from any part of the island with little if any loss, and allowed to ripen at the market. Sorting them into large and small grades will improve their general appearance and make them attractive to the purchaser. By picking and marketing in the manner above described one can keep tomatoes much longer and with less likelihood of disease.

In 23 tests conducted by the experiment station the average time between planting and the first matured fruits was found to be 82 days, and from the first harvest to the last harvest an average of 76 days.

#### TURNIP (*Brassica rapa*).

Turnips do not do as well in Guam as they do in the States. They grow to about half the ordinary size and have a tendency to become pithy before they fully develop. The seeds are planted in rows 12 to 18 inches apart, and the plants are thinned to 3 inches apart in the row. Soil requirements and cultivation for turnips are the same as for radish. A longer time is required to mature turnips than is required for the radish, and they are ready to be eaten as soon as they are large enough. Turnips should be harvested while they are tender and sweet. In 14 tests made with this vegetable the average time each crop occupied the ground was 90 days, 62 of which elapsed before the first turnips were harvested.

#### WATERMELON (*Citrullus vulgaris*).

The watermelon is very much liked by the Chamorro people. It can easily be grown in large quantities if it is given proper care and cultivation. (Pl. XVII, fig. 2.) The varieties introduced by the experiment station are of much better quality and more in demand

than are the smaller native melons. At present the local demand for the introduced varieties is greater than the supply.

Watermelons are particular as to soil types and will not grow in low, soggy soil and soil that dries out very quickly. They should be grown in a light, mellow, sandy loam, underlain by a subsoil which will retain moisture. Good watermelons can also be produced on newly prepared land, provided that it is well drained. The size and number of melons from an area can be materially increased if manure is applied to the soil, or a crop of green cowpeas is turned under before planting.

Rows should be laid off 6 feet apart, and if the plantings are made before the rainy season is over the beds should be raised so as to provide drainage for the plants. This can be done by plowing a few furrows together and by planting the seeds on the ridges in hills 6 feet apart. Manure should be placed in each hill because it provides one of the best fertilizers for watermelon. Several seeds should be dropped in a hill and covered 2 inches deep. Later the plants should be thinned to two healthy vines in a hill. Cultivation, sufficient to keep down weeds and to preserve the mellowness of the soil, is all that is required. After the vines have made a good start, the cultivation should be shallow, so that it will not injure the roots of the plants. Weeds should be pulled by hand until the vines reach a stage where the tendrils wrap around them. They should then be removed without disturbing the vines.

The proper time to pick a watermelon can be determined only by experience. The tendrils on the vine opposite the melon wither and turn brown when the melon is ripening, but they may do this several days before or after the melon is ready to be picked. Some people look at the underside of the melon, where it is in contact with the soil. When the melon is green this part is white, and as the melon ripens it changes to a yellowish color and turns hard. Ripeness can best be determined by thumping the melon with the finger. A green melon when thumped gives off a clear or ringing sound, as in striking something hollow, while a ripe melon sounds dull or dead, as when a solid body is struck.

Showers are of frequent occurrence in Guam, and it often happens that the melons, which lie flat on the wet ground, start to rot. During these periods it is advisable to place small pieces or frames of bamboo under the larger melons to raise them an inch or two off the ground. This prevents the starting of rot and is an inexpensive method which requires very little labor and time.

In 14 tests made by the experiment station an average of 109 days from the time of planting was required for the first melons to become ripe enough for picking. The vines continued to bear for an



average of 48 days afterwards, making 157 days for the plants to occupy the land. Many varieties, including some of the old standard varieties such as Halbert Honey, Florida Favorite, and Rattlesnake, were tried at various times, and although some produced fruits of good quality, none equaled those produced by the Tom Watson variety. This variety seems to be well adapted to local conditions, and seeds are much in demand during the planting season.

#### YAMS (*Dioscorea* spp.).

Yams grow well and are commonly used as food in Guam, although they are not extensively planted as a field or garden crop. These plants have very large, irregularly shaped rootstocks, which are very starchy and contain only little sugar. These rootstocks sometimes weigh from 50 to 100 pounds. The vines are long, twining, rather coarse, and produce a large number of heart-shaped or arrow-like leaves, according to the variety.

A soil that can be deeply prepared is better than a hard or stony soil. It is a common practice to plant yams around trees that have been killed in clearing. Long poles are placed in a leaning position against the tree from the hill where the yam is planted. After being planted the yam receives little care other than keeping down weed growth. If large areas are to be devoted to yam growing, the ground should be plowed or dug up as deep as possible.

In the propagation of this vegetable usually the tops of the rootstocks are cut off and planted, leaving the vines attached. These then produce roots which have numerous buds. Before being planted in the field the roots are cut into small pieces, each piece containing one or two buds. Pieces of the large stem end of the root may also be used for planting. They are planted 6 inches deep and about 3 feet apart each way. A better yield is secured by staking, which consists in leaning 3 or 4 poles together and tying them at the top, allowing the vines to climb the stakes. In cultivating, the dirt is thrown up around the hills.

The yams are harvested in 7 to 9 months after being planted. When the vines turn yellow and the leaves begin to fall the yam is ready for harvesting. This usually occurs during the dry season. The rootstock is perennial, the vine dying down during the dry season and coming out new when the rains start. The yam is a good keeper, even after it has been removed from the ground. They are often dug and kept in the house, being sorted over occasionally to remove any that show signs of decay.

A number of different kinds of yams grow in Guam. Some are large, weighing almost a hundred pounds in some instances; others

are very small, weighing only a few ounces. They are white, yellow, and purple in color. Both the white or square-stemmed yam and the common or round-stemmed yam are grown in rather large quantities. The native people divide the cultivated varieties into two classes, "nika" and "dago," according to the size and shape of the root and leaves. A wild species called "gado" is found growing in the woods. It has long, curved, sharp spines just above the enormous roots. Yams are easily grown, give large yields, and are available at all times of the year.

YAM BEAN (*Pachyrhizus tuberosus*).

This leguminous plant produces a large, edible tuberous root. The plant was evidently derived from Mexico as its local name, "hikamas," is probably derived from "jicama" of that country. The yam bean is occasionally planted in the gardens of Guam. Its roots, which somewhat resemble the turnip, are crisp, sweet, and very tender before reaching maturity. They can be eaten cooked or raw. Although the beans are edible they are not eaten here, but are often kept picked off the vines so that the root will make larger growth.

The seeds are planted 2 inches deep and 8 to 10 inches apart in rows 3 feet between the rows. Larger yields can be expected if trellises are provided for the vines. Bamboo brush, if pushed well down into the soil, makes a very good support. The roots will grow larger if the seeds are not allowed to mature, but they should be harvested before becoming coarse and woody. When the seeds are allowed to remain on the vines the maturity of the plant can be indicated by the ripening of the seeds. The roots are best harvested before the beans fully ripen.













